Bindery

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View down one of the Aisles of the Salon.

NOVELTIES AT THE PARIS AERONAUTIC EXHIBITION.—[See page 344.]

Facts and Fancy About Ventilation—I*

Chemical Composition of the Air an Imperfect Criterion of Its Health Value

By Leonard Hill, M.B., F.R.S.

Everyone thinks that he suffers in an ill-ventilated room owing to some change in the chemical quality of the air, be it want of oxygen, or excess of carbon dioxide, the addition of some exhaled organic poison, or the destruction of some subtle property by passage of the air over steam-coils, or other heating or conducting apparatus. We hear of "devitalized" or "dead" air, and of "tinned" or "potted" air of the battleship. The good effects of open-air treatment, sea and mountain air, are no less generally ascribed to the chemical purity of the air. In reality the health-giving properties are those of temperature, light, movement, and relative moisture of the surrounding atmosphere, and leaving on one side those gross chemical impurities which arise in mines and in some manufacturing processes, and the question of bacterial infection, the alterations in chemical composition of the air in buildings where people crowd together and suffer from the effects of ill-ventilation have nothing to do with the causation of these effects.

Satisfied with the maintenance of a specious standard of chemical purity, the public has acquiesced in the elevation of sky-scrapers and the sinking of cavernous places of business. Many have thus become cave-dwellers, confined for most of their waking and sleeping hours in windless places, artificially lit, monotonously warmed. The sun is cut off by the shadow of tall buildings and by smoke, the sun, the energizer of the world, the giver of all things which bring joy to the heart of man, the fitting object of worship of our forefathers.

The ventilating and heating engineer hitherto has followed a great illusion in thinking that the main objects to be attained in our dwellings and places of business are chemical purity of the air and a uniform draughtless summer temperature.

Life is the reaction of the living substance to the ceaseless play of the environment. Biotic energy arises from the transformation of those other forms of energy, heat, light, sound, etc., which beat upon the transformer, the living substance (B. Moore). Thus, when all the avenues of sense are closed, the central nervous system is no longer aroused and consciousness lapses. The boy paralyzed in almost all his avenues of sense fell asleep whenever his remaining eye was closed. The patient who lost one labyrinth by disease, and, to escape unendurable vertigo, had the other removed by operation, was quite unable to guide his movements or realize his position in the dark. Rising from bed one night, he collapsed on the floor and remained there helpless until succor arrived.

A sense organ is not stimulated unless there is a change of rate in the transference of energy; and this to be effectual must occur in most cases with considerable quickness. If a weak agent is to stimulate, its application must be abrupt (Sherrington). Thus, the slow changes of barometric pressure on the body-surface originate no skin sensations, though such changes of pressure if applied suddenly, are much above the threshold value for touch. A touch excited by constant mechanical pressure of slight intensity fades quickly below the threshold of sensation. Thus, the almost unbearable discomfort which a child feels on putting on for the first time a "natural" wool vest fades away, and is no longer noticed with continual wear. Thomas à Beckett soon must have become oblivious to his hair-shirt, and even to its harbingers. It is not the wind which God tempers to the shorn lamb, but the skin of the lamb to the wind. The inflow of sensations keeps us active and alive and all the organs working in their appointed functions. The cutaneous sensations are of the highest importance. The salt and sand of wind-driven sea air particularly act on the skin and through it brace the whole body. The changing play of wind, of light, cold, and warmth stimulate the activity and health of mind and body. Monotony of sedentary occupation and of an overwarm still atmosphere endured for long working hours destroys vigor and happiness and brings about the atrophy of disuse. We hear a great deal of the degeneration of the race brought about by city life, but observation shows us that a drayman, navvy, or policeman can live in London, or other big city, strong and vigorous, and no less so than in the country. The brain-worker, too, can keep himself perfectly fit if his hours of sedentary employment are not too long and he balances these by open-air exercise. The horses stabled, worked, and fed in London are as fine as any in the world; they do not live in windless rooms heated by radiators.

The hardy men of the north were evolved to stand the vagaries of climate, cold and warmth, a starved or full belly have been their changing lot. The full belly and the warm sun have expanded them in lazy comfort; the cold and the starvation have braced them to action. Modern civilization has withdrawn many of us from the struggle with the rigors of nature; we seek for and mostly obtain the comfort of a full belly and expand all the time in the warm atmosphere afforded us by clothes, wind-protected dwellings, and artificial heat, particularly so in the winter, when the health of the business man deteriorates. Cold is not comfortable, neither is hunger; therefore we are led to ascribe many of our ills to exposure to cold, and seek to make ourselves strong by what is termed good living. I maintain that the bracing effect of cold is of supreme importance to health and happiness, that we become soft and flabby and less resistant to the attacks of infecting bacteria in the winter, not because of the cold, but because of our excessive precautions to preserve ourselves from cold; that the prime cause of "cold" or "chill" is not really exposure to cold, but to the overheated and confined air of rooms, factories, and meeting-places. Seven hundred and eleven survivors were saved from the "Titanic" after hours of exposure to cold. Many were insufficiently clad and others wet to the skin. Only one died after reaching the "Carpathia," and he three hours after being picked up. Those who died perished from actual cooling of the body. Exposure to cold did not cause in the survivors the diseases commonly attributed to cold.

Conditions of city and factory life diminish the physical and nervous energy, and reduce many from the vigorous health and perfectness of bodily functions which a wild animal possesses to a more secure, but poorer and far less happy, form of existence. The ill-chosen diet, the monotony and sedentary nature of daily work, the windless uniformity of atmosphere, above all, the neglect of vigorous muscular exercise in the open air and exposure to the winds and light of heaven, all these, together with the difficulties in the way of living a normal sexual life, go to make the pale, undeveloped, neurotic, and joyless citizen. Nurture in unnatural surroundings, not nature's birth-mark, molds the criminal and the wastrel. The environment of childhood and youth is at fault rather than the stock; the children who are taken away and trained to be sailors, those sent to agricultural pursuits in the Colonies, those who become soldiers, may develop a physique and bodily health and vigor in striking contrast to their brothers who become clerks, shop assistants, and compositors.

Too much stress cannot be put on the importance of muscular exercise in regard to health, beauty, and happiness. Each muscle fills with blood as it relaxes, and expels this blood on past the venous valves during contraction. Each muscle, together with the venous valves, forms a pump to the circulatory system. It is the function of the heart to deliver the blood to the capillaries, and the function of the muscles, visceral, respiratory, and skeletal, to bring it back to the heart. The circulation is contrived for a restless mobile animal; every vessel is arranged so that muscular movement furthers the flow of blood.

The pressure of the blood in the veins and arteries under the influence of gravity varies with every change of posture. The respiratory pump, too, has a profound influence on the circulation. Active exercise, such as is taken in a game of football, entails endless changes of posture, varying compressive actions, one with another struggling in the rough and tumble of the game, forcible contractions and relaxations of the muscles, and a vastly increased pulmonary ventilation; at the same time the heart's action is accelerated and augmented and the arterial supply controlled by the vasomotor system. The influence of gravity, which tends to cause the fluids of the body to sink into the lower parts, is counteracted; the liver is rhythmically squeezed like a sponge by the powerful respiratory movements, which not only pump the blood through the abdominal viscera but thoroughly massage these organs, and kneading these with the omentum clean the peritoneal cavity and prevent constipation. At the same time the surplus food metabolic products, such as sugar and fat, stored in the liver, are consumed in the production of energy, and the organs swept with a rapid stream of blood containing other products of muscular metabolism which are necessary to the interrelation of chemical action. The output of energy is increased very greatly: a resting man may expend two thousand calories per diem; one bicycling hard for most of the day expended eight thousand calories, of which only four thousand was covered by the food eaten.

Such figures show how fat is taken off from the body by exercise, for the other four thousand calories comes from the consumption of surplus food products stored in the tissues. While resting a man breathes some 7 liters of air, and uses 300 cubic centimeters of oxygen per minute, against 140 liters and 3,000 cubic centimeters while doing very hard labor. The call of the muscles for oxygen through such waste products as lactic acid impels the formation of red corpuscles and hæmoglobin. The products of muscular metabolism in other ways not yet fully defined modify the metabolism of the whole body.

Exposure to cold, cold baths, and cold winds has a like effect, accelerating the heart and increasing the heat production, the activity of the muscles, the output of energy, the pulmonary ventilation, and intake of oxygen and food. In contrast with the soft pot-bellied, over-fed city man the hard, wiry fisherman trained to endurance has no superfluity of fat or tissue fluid. His blood volume has a high relative value in proportion to the mass of his body. His superficial veins are confined between a taut skin and muscles, hard as in a racehorse trained to perfection. Thus, the adequacy of the cutaneous circulation and loss of heat by radiation rather than by sweating is assured. His fat is of a higher melting point, hardened by exposure to cold. In him less blood is derived to other parts, such as adipose tissue, skin, and viscera. He uses up the oxygen in the arterial blood more completely and with greater efficiency; for the output of each unit of energy his heart has to circulate much less blood (Kreogh); his blood is sent in full volume by the well-balanced activity of his vasomotor system to the moving parts. Owing to the perfect co-ordination of his muscles, trained to the work, and the efficient action of his skin and cutaneous circulation, the radiator of the body, he performs the work with far greater economy and less fatigue. The untrained man may obtain 12 per cent of his energy output as work, against 30 per cent, or perhaps even 50 per cent, obtained by the trained athlete. Hence, the failure and risk suffered by the city man who rushes straight from his office to climb the Alps. On the other hand, the energetic man of business or brain worker is kept by his work in a state of nervous tension. He considers alternative lines of action, but scarcely moves. He may be intensely excited, but the natural muscular response does not follow. His heart is accelerated and his blood pressure raised, but neither muscular movements and accompanying changes of posture, nor the respiratory pump materially aid the circulation. The activity of his brain demands a rapid flow of blood, and his heart has to do the circulatory work, as he sits still or stands at his desk, against the influence of gravity. Hence, a high blood pressure is maintained for long periods at a time by vaso-constriction of the arteries in the lower parts of the body and increased action of the heart; hence, perhaps, arise those degenerative changes in the circulatory system which affect some men tireless in their mental activity. We know that the bench-worker, who stands on one leg for long hours a day, may suffer from degeneration and varicosity of the veins in that leg. Long-continued high arterial pressure, with systolic and diastolic pressures approximately the same, entails a stretched arterial wall, and this must impede the circulation in the vaso-vasorum, the flow of tissue lymph in, and nutrition of, the wall. Since his sedentary occupation reduces the metabolism and heat production of his body very greatly, the business man requires a warmer atmosphere to work in. If the atmosphere is too warm it reduces his metabolism and pulmonary ventilation still further; thus he works in a vicious circle. Exhausting work causes the consumption of certain active principles, for example, adrenin, and the reparation of those must be from the food. To acquire certain of the rarer principles expended in the manifestation of nervous energy more food may have to be eaten by the sedentary worker than can be digested and metabolized. His digestive organs lack the kneading and massage, the rapid circulation and oxidation of foodstuffs which is given by muscular exercise. Hence, arise the digestive and

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metabolic ailments so common to some brain workers.

Mr. Robert Milne informs me that of the thousands of children who have passed through Banardo's Homes, there are 9,000 in the homes at any one time, not one after entering the institution and passing under its regimen and the care of his father, Dr. Milne, has developed appendicitis. Daily exercise and play, adequate rest, a regular, simple diet have insured their immunity from this infection. It pays to keep a horse healthy and efficient; it no less pays to keep men healthy. I recently investigated the case of clerks employed in a great place of business, whose working hours are from 9 to 6 on three days, and 7 to 9 on the other three days of each week, and working such overtime, they make £1 to £2 a week; these clerks worked in a confined space, forty or fifty of them in 8,200 cubic feet, lit with thirty electric lamps, cramped for room, and overheated in warm summer days. It is not with the chemical purity of the air of such an office that fault is to be found, for fans and large openings insured this sufficiently. These clerks suffered from their long hours of monotonous and sedentary occupation, and from the artificial light, and the windless, overwarm and moist atmosphere. Many a girl cashier has worked from 8 to 8:30, and on Saturdays from 8 to 10, and then has had to balance her books and leave, perhaps after midnight, on Sunday morning. Her office is away in the background, confined, windless, artificially lit. The Shops Act has given a little relief from these hours. What, I ask, is the use of the State spending a million a year on sanatoria and tuberculin dispensaries, when those very conditions of work continue which lessen the immunity and increase the infection of the workers?

The jute industry in the town of Dundee is carried out almost wholly by female and boy labor. "The average wages for women are below 12 shillings in eight processes, and above 12 shillings, but under 18 shillings, for the remaining five processes." The infant mortality has been more than 170 per 1,000. The Social Union of Dundee reported in 1905 that of 885 children born to 240 working mothers no fewer than 520, or 59 per cent, died, and almost all of them were under five years of age. The life of these mothers was divided between the jute factory and the one-roomed tenement. Looking such conditions squarely in the face, I say it would be more humane for the State to legalize the exposure of every other new-born infant on the hillside rather than allow children to be slowly done to death. The conditions, as given in the report, contravene those rights of motherhood which the meanest wild animal can claim.

Isolation hospitals, sputum-pots, and anti-spitting regulations will not stamp out tuberculosis. Such means are like shutting the door of the stable when the horse has escaped. Flügge has shown that tubercle bacilli are spread by the droplets of saliva which are carried out as an invisible spray when we speak, sing, cough, sneeze. Sputum-pots cannot control this. The saliva of cases of phthisis may teem with the bacilli. The tuberculin reaction tests carried out by Hamburger and Monti in Vienna show that 94 per cent of all children aged eleven to fourteen have been infected with tubercle. In most the infection is a mere temporary indisposition. I believe that the conditions of exhausting work, and amusement in confined and overheated atmospheres, together with ill-regulated feeding, determine largely whether the infection, which almost none can escape, become serious or not. Karl Pearson suggests that the death statistics afford no proof of the utility of sanatoria or tuberculin dispensaries, for during the very years in which such treatment has been in vogue, the fall in the mortality from tuberculosis has become less relatively to the fall in general mortality. He opines that the race is gradually becoming immune to tubercle, and hence the declination in the mortality curve is becoming flattened out, that nature is paramount as the determinant of tuberculosis, not nurture. From a statistical inquiry into the incidence of tuberculosis in husband and wife and parent and child, Pearson concludes that exposure to infection as in married couples is of little importance, while inborn immunity or diathesis is a chief determinant. Admitting the value of his critical inquiries and the importance of diathesis, I would point out that in the last few years the rush and excitement of modern city life has increased, together with the confinement of workers to sedentary occupations in artificially lit, warm, windless atmospheres. The same conditions pertain to places of amusement, eating-houses, tube railways, etc.

Central heating, gas-radiators, and other contrivances are now displacing the old open fire and chimney. This change greatly improves the economical consumption of coal and the light and cleanliness of the atmosphere. But in so far as it promotes monotonous, windless, warm atmospheres, it is wholly against the health and vigor of the nation. The open fire and wide chimney insure ventilation, the indrawing of cold outside air, streaky air, restless currents at different temperatures, which strike the sensory nerves in the skin and prevent monotony and weariness of spirit. By the old open fires we were heated with radiant heat. The air in the rooms was drawn in cool and varied in temperature. The radiator and hot-air system give us a deadly uniformly heated air, the very conditions we find most unsupportable on a close summer's day.

In Labrador and Newfoundland, Dr. Wakefield tells me, the mortality of the fisherfolk from tuberculosis is very heavy. It is generally acknowledged to be four per thousand of the population per annum, against 1.52 for England and Wales. Some of the Labrador doctors talk of seven and even eight per thousand in certain districts. The general death rate is a low one. The fishermen fish off shore, work for many hours a day in the fishing season, and live with their families on shore in one-roomed shanties. These shanties are built of wood, the crannies are "stogged" with moss, and the windows nailed up, so that ventilation is very imperfect. They are heated by stoves and kept at a very high temperature, e. g., 80 deg. Fahr. Outside in the winter the temperature may be 30 degrees below freezing. The women stay inside the shanties almost all their time, and the tuberculosis rate is somewhat higher in them. The main food is white bread, tea stewed in the pot till black, fish occasionally, a little margarine and molasses. The fish is boiled and the water thrown away. Game has become scarce in recent years; old, dark-colored flour, spoken of with disfavor, has been replaced by white flour. In consequence of this diet beri-beri has become rife to a most serious extent, and the hospitals are full of cases. Martin Flack and I have found by our feeding experiments that rats, mice, and pigeons cannot be maintained on white bread and water, but can live on wholemeal, or on white bread in which we incorporate an extract of the sharps and bran in sufficient amount. Recent work has shown the vital importance of certain active principles present in the outer layers of wheat, rice, etc., and in milk, meat, etc., which are destroyed by heating to 120 deg. Cent. A diet of white bread or polished rice and tinned food sterilized by heat is the cause of beri-beri. The metabolism is endangered by the artificial methods of treating foods now in vogue. As to the prevalency of tuberculosis in Labrador, we have to consider the intermarriage, the bad diet, the over-rigorous work of the fishermen, the overheating of, and infection in, the shanties. Dr. Wakefield has slept with four other travelers in a shanty with father, mother, and ten children. In some there is scarce room on the floor to lie down. The shanties are heated with a stove on which pots boil all the time; water runs down the windows. The patients are ignorant, and spit everywhere, on bed, floor, and walls. In the schools the heat and smell are most marked to one coming in from the outside air. In one school 50 cubic feet per child is the allowance of space. The children are eating all day long, and are kept in close, hot confinement. They suffer very badly from decay of the teeth. Whole families are swept off with tuberculosis, and the child who leaves home early may escape, while the rest of a family die.

Here, then, we have people living in the wildest and least populated of lands with the purest atmosphere suffering from all those ill-results which are found in the worst city slums, tuberculosis, beri-beri, and decayed teeth.

The bad diet probably impels the people to conserve their body heat and live in the over-warm, confined atmosphere, just as our pigeons fed on white bread sit, with their feathers out, huddled together to keep each other warm. The metabolism, circulation, respiration, and expansion of the lung are all reduced. The warm, moist atmosphere lessens the evaporation from the respiratory tract, and therefore the transudation of tissue lymph and activity of the ciliated epithelium. The unexpanded parts of the lung are not swept with blood. Everything favors a lodgment of the bacilli, and lessens the defences on which immunity depends. In the mouth, too, the immune properties of the saliva are neutralized by the continual presence of food, and the temperature of the mouth is kept at a high level, which favors bacterial growth. Lieut. Siem informs me that recently in Northern Norway there has been the same notable increase in tuberculosis. The old cottage fireplaces with wide chimneys have been replaced with American stoves. In olden days most of the heat went up the chimney, and the people were warmed by radiant heat. Now the room is heated to a uniform moist heat. The Norwegians nail up the windows and never open them during the winter. At Lofoten, the great fishing center, motor-boats have replaced the old open sailing and row boats. The cabin in the motor-boat is very confined, covered in with watertight deck, heated by the engine, crowded with six or eight workers. When in harbor the fishermen used to occupy ill-fitted shanties, through which the wind blew freely; now, to save rent, they sleep in the motor-boat cabins.

Here, again, we have massive infection, and the reduction of the defensive mechanisms by the influence of the warm, moist atmosphere.

The Norwegian fishermen feed on brown bread, boiled fish, salt mutton, margarine, and drink, when in money, beer and schnapps; there is no gross deficiency in diet, as in Labrador, and beri-beri does not attack them. They return home to their villages and longshore fishing when the season is over. The one new condition which is common to the two districts is confinement in stove-heated, windless atmospheres. In old days the men were crowded together, but in open boats or in draughty shanties, and had nothing but little cooking stoves.

The conditions of great cities tend to confine the worker in the office all day, and to the heated atmosphere of club, cinema show, or music hall in the evening. The height of houses prevents the town dweller from being blown upon by the wind, and, missing the exhilarating stimulus of the cool, moving air, he repels the dull uniformity of existence by tobacco and by alcohol, or by indulgence in food, e. g., sweets, which are everywhere to his hand, and by the nervous excitement of business and amusement. He works, he eats, and is amused in warm, windless atmospheres, and suffers from a feeble circulation, a shallow respiration, a disordered digestion, and a slow rate of metabolism.

Many of the employments of modern days are detestable in their long hours of confinement and monotony. Men go up and down in a lift all day, and girls in the bloom of youth are set down in tobacco stalls in underground stations, and their health and beauty there fade while even the blow-flie are free to bask in the sun. In factories the operatives feed machines, or reproduce the same small piece of an article day after day. There is no art, or change; no pleasure in contrivance and accomplishment. The miner, the fisherman, even the sewer-man, face difficulties, changing risks, and are developed as men of character and strength. Contrast the sailor with the steward on a steamer, the drayman outside with the clerk inside who checks the goods delivered at some city office, the butcher and the tailor, the seamstress and the market woman, and one sees the enormous difference which a confined occupation makes. Monotonous, sedentary employment makes for unhappiness because the inherited functional needs of the human body are neglected, and education—when the outside field of interest is narrowed—intensifies the sensitivity to the bodily conditions. The sensations arising within the body—proprioceptive sensations—come to have too large a share in consciousness in comparison with exteroceptive. In place of considering the lilies how they grow, or musing on the beauty and motions of the heavenly bodies, the sedentary worker in the smoke-befouled atmosphere, with the limited activity and horizon of an office and a disturbed digestion, tends to become confined to the inward consideration of his own viscera and their motions.

Many of the educated daughters of the well-to-do are no less confined at home; they are the flotsam and jetsam cast up from the tide in which all others struggle for existence—their lives are no less monotonous than the sweated sempstress or clerk. They become filled with "vapors" and some seek excitement not at the cannon's mouth but in breaking windows, playing with fire, and hunger strikes. The dull monotony of idle social functions, shopping and amusement no less than that of sedentary work and an asexual life, impels to a simulated struggle—a theatrical performance, the parts of which are studied from the historical romances of revolution. Each man, woman, and child in the world must find the wherewithal for living, food, raiment, warmth, and housing, or must die or get some other to find it for him. It seems to me as if the world is conducted as if ten men were on an island—a microcosm—and five sought for the necessaries of life, hunted for food, built shelters and fires, made clothes of skins, while the other five strung necklaces of shells, made loin-cloths of butterfly wings, gambled with knuckle-bones, drew comic pictures in the sand, or carved out of clay frightening demons, and so beguiled from the first five the larger share of their wealth. In this land of factories, while the many are confined to mean streets and wretched houses, possessing no sufficiency of baths and clean clothing, and are ill-fed, they work all day long, not to fashion for themselves better houses and clothing, but to make those unnecessaries such as "the fluff" of women's apparel, and a thousand trifles which relieve the monotony of the idle and bemuse their own minds.

While outdoor work disciplines the body of the countryman into health, the town man needs the conscious attention and acquired educated control of his life to give him any full measure of health and happiness.

(To be continued.)

Sir William Ramsay in his Laboratory.

Sir William Ramsay, K.C.B., F.R.S.*

Famous for his Researches on Helium and the other rare gases of the Atmosphere

By Prof. W. Ostwald

If we endeavor to build up to its highest pinnacle Auguste Comte's pyramid of sciences, in which natural science follows upon mathematics, and is succeeded by physiology, and finally by sociology, we reach as the highest of imaginable sciences the science of Geniology, the science of genius, of the excelling man. That such a science is possible has been known for half a century. The investigations of Sir Francis Galton in England, of de Candolle in Geneva, and of some recent workers in Germany, have proved to demonstration that even this rare and shining phenomenon is subject to definite natural laws, discoverable by a careful scrutiny of available facts, laws the significance of which is very great, since the position of any nation among the nations of the world is determined by the qualities and the efficiency of its men of genius.

On surveying the life of Sir William Ramsay in the light of this the youngest of the sciences, one is struck by the extraordinary consistency to be found in it, a consistency by virtue of which the rapid succession of astonishing discoveries filling the latter portion of his life appears as the necessary consequence of a natural and regular process, and almost resembles the working of a machine. Here we find nothing of the irregular curves with distinct maxima occurring in other types of genius, and usually in the most marked degree in youth, as in the case of Sir Humphry Davy, Sir William Ramsay's fellow-countryman, who resembles him in many respects. Ramsay recalls Davy by the brilliancy and the striking originality of his discoveries, which had no relation with any school or predecessor. In Davy's case these discoveries appear more as disconnected peaks suddenly arising from an average level. In Ramsay's case, on the other hand, we can observe how one discovery follows another, how comparatively modest and unobtrusive investigations, which have been accepted in their due place in the great register of the sciences, appear as the necessary foundations for truths of such novelty that their possibility was not even conceived before they were scientifically communicated.

This natural-law consistency is seen in the first instance in William Ramsay's descent. He has himself explained that his male ancestors for seven generations were dyers, thus handing down to him as a long inheritance a familiarity with chemical processes and a facility in chemical ways of thinking. On the mother's side, again, a series of physicians have provided the inherited capacity of the great scientific discoverer. But of all these men, none even remotely resembles Sir William in his eminence among his contemporaries, and, in this case, as in all similar cases, the question arises, how it is possible that such a genius arises from people of good average capacity.

It has, indeed, been established by Galton that an efficiency exceeding the average, but not amounting to genius, is in some families inherited through a whole series of generations. But here we have to deal with one of those extraordinary cases where an average efficiency was well evidenced through a number of generations, but suddenly made way for an incomparably higher personality, in which indeed the characteristic qualities of previous generations can be recognized, but which far surpasses its progenitors in efficiency.

If we bear in mind the well-known laws of heredity discovered by Mendel and de Vries, we know that every descendant is a mosaic of those qualities which have been transmitted to him partly by the father and partly by the mother. In the face of this fact the problem arises how such an unusual personality can be descended from parents of average ability, since it is just from these laws of heredity that we should conclude that another average equipment would result.

The answer which I tentatively should venture as regards this problem is this: The portions of the inheritance constituting a new being probably only on rare occasions fit together or harmonize with each other. The adolescent man then applies the greatest portion of his energy in the task of organizing these accidental inheritances for the purpose of common work and harmonious co-operation, and this task uses up the greater part of the available energy, and withdraws it from productive work. It is only in rare cases that the inheritances are so constituted that they fit each other from the beginning, so that the young man has not to expend any energy on the mutual harmonizing of his elements, but can immediately set about his creative work. Such a case seems to be that of Sir William Ramsay. On one occasion he described himself as a precocious, dreamy youth, of somewhat unconventional education. The precociousness is a practically universal phenomenon of incipient genius, and the dreamy quality indicates that original production of thought which lies at the basis of all creative activity.

His father, being a man of practical pursuits, who, however, in his free time zealously cultivated scientific works, such as quaternions and geology, introduced young William to the great passion of his life, chemistry, and, as is often the case, an accident was the immediate cause of the new departure. Young William had broken a leg at football, and to ease the tedium of convalescence, his father had given him Graham's "Chemistry" to study, and also brought him small quantities of many chemicals with which he could carry out the experiments described in the text-book. Sir William himself says that it was chiefly the question how fireworks could be prepared which induced him to study Graham's "Chemistry." But very soon the general scientific interest gained the upper hand, and this can very characteristically be gathered from the fact that he persuaded his people to take a practical part in the pursuits which interested him. In his fourteenth year William matriculated at Glasgow University, and there commenced his studies. The greatest influence was exerted upon him by William Thomson, whose curious and impressive method of teaching has been graphically and amusingly described by his great pupil. He gave him as a first problem a large heap of old copper wire in the laboratory, and instructed him to take out the kinks from it, and from the way in which the young student accomplished the task Thomson seems to have derived a favorable judgment as to his capacity for solving larger problems. For he soon made him acquainted with the quadrant electrometer, an instrument which at that time only existed in Glasgow, and instructed him to determine the potential difference between all kinds of objects found in the laboratory, or imported into it, such as a children's toy balloon. We can imagine that if such an originally constituted spirit could be at all affected by teaching, he must have been profoundly affected by this teacher. For William Thomson belonged to the same type of "romantic" or rapidly producing investigators as did Ramsay himself, and hence he made a particularly strong and permanent impression on that plastic developing genius.

The regular study of chemistry which followed upon this irregular course was made under Tatlock in Glasgow, and in this case also Ramsay appears to have distinguished himself so decidedly that his teacher after a short time made him an occasional deputy in the class.

At eighteen years of age the young student in Glasgow had learned whatever was to be learned there, and he had now to pursue his further study of chemistry. For this only Germany was at that time to be considered. But the Franco-German war had just broken out, and it therefore appeared somewhat risky to follow the original idea of continuing his studies in Heidelberg under Bunsen. However, the scene of war moved away so rapidly from the Franco-German frontier, that the German project could be undertaken. Ramsay passed one term with Bunsen, without, however, seem-

* Biographical sketch reproduced from *Nature*.

ing to carry away a very strong impression, for in the following term he moved on to Tubingen, where he met a number of equally disposed fellow-workers in Fittig's laboratory, and under the guidance of this extremely conscientious teacher and able experimenter he was introduced to the usual problems and methods of organic chemistry. There Ramsay made one of the usual dissertations (on toluyl acids), which does not enable us to recognize the kind of man we have to deal with. After his return Ramsay was for some years assistant in the Glasgow course of study and there he acquired a very extensive and profound knowledge of the whole field, especially of inorganic chemistry, at the same time laying the foundations of that mastery which he subsequently displayed as teacher in a great laboratory. Nor shall we err in supposing that the method of working a laboratory, as developed under the inspiring guidance of Liebig in Germany, and spread over the laboratories of the whole world as common property of chemical science, has exerted a very profound influence on Ramsay's talents and ideals as a teacher. In any case, we can state that he has approached the great example of Liebig as closely as any distinguished teacher of chemistry since that great time. Particularly in England his extraordinary facility of organizing work in a great laboratory, with a diversity of the most varied talents, must be regarded as very rare, considering that they spread over many different regions of science, and thus make results possible which turn out afterward to be of fundamental importance.

It is very interesting to observe from Ramsay's own communications how he gradually found his way out of organic chemistry, at that time the object of chief interest, into that other region which has since found an independent place as physical, or rather general chemistry. It was first certain practical problems, such as the determination of vapor densities, which introduced him to the more physical problems of chemistry. Here we find the first marks of the growing genius, in the extraordinary independence in the choice of means of solving the problem. Thus he used the pitches of pipes of fixed dimensions for the determination of vapor densities, and thus utilized his own musical talents.

This process was successful (although it has never been published), but he was less fortunate in his attempts to measure the electric conductivity of solutions by means of the telephone. Here we are involuntarily brought to a pause and have to ask ourselves how the geographical distribution of discoveries in electrochemistry, such as have reformed chemistry in the last twenty years, would have arranged itself if the young investigator had at that time been more fortunate in the execution of his experimental ideas.

We also know of physiological investigations concerning anæsthetics, dating from this period, executed in company with some medical colleagues. In these he himself was the experimental subject, as he suffered less under them than his companions. But here also no considerable results were obtained.

The first independent position was obtained by William Ramsay in the year 1880, when the professorship at the University College, Bristol, was intrusted to him. The choice fell upon him in preference to a competitor because, as he himself narrates, he understood Dutch. For he had to make visits to the various members of the council of the College, and was fortunate enough to be of assistance to one of them, an old minister, in the translation of a Dutch text, so that this member gave him his vote, and the choice was made with a majority of one. But soon it turned out to be an exceptionally happy one. A year after that Ramsay was chosen as the principal of the College. In this short time he had not only proved himself to be an excellent teacher, but also an excellent organizer.

The problem of vapor densities, which had first introduced him to physical chemistry, gave rise to further investigation, in the course of which the habit of expressing experimental results by mathematical formulæ, learned from Sir William Thomson, turned out to be extraordinarily valuable. In this connection originated the fundamental works on evaporation and dissociation, carried out in great part with his assistant, Sydney Young, which first drew the attention of the larger circles of the scientific world upon him. Here also it is suggestive to note how one followed on the other. His intervention in a controversy which was at that time raging in the columns of *Nature* concerning "hot ice" suggested to him the possibility of determining the relation between vapor pressure and temperature by introducing into a space under the pressure in question a thermometer the bulb of which was covered with the body under investigation, in this case ice. The resulting temperature corresponding to the pressure turned out to be so precise that the process was soon developed as a general method of determining vapor pressure.

These investigations, which have been published in a number of large essays in the *Philosophical Transactions*, gave the impetus which led to the appointment of the still youthful professor to the highly esteemed chair at the University College, London, which Sir William Ramsay still adorns. It is true that at that time the great value of these works was imperfectly recognized, and I remember having an opportunity of pointing out to the authorities of the University College with great emphasis that we had here to do with investigations carrying us considerably further than the determinations of the great physicist Regnault, who was then regarded as the first authority on the whole subject.

At this point began the rapid succession of works which brought Ramsay to the scientific eminence which he still occupies. The measurements of surface tensions up to the critical temperature led to the well-known law which allows us to determine molecular weights in liquids. An occasional lecture experiment, during which magnesium nitride was produced, suggested to him to co-operate with Lord Rayleigh in the solution of the problem proposed by the latter concerning the difference in density between nitrogen derived from the air and artificial nitrogen.

By heating nitrogen from the air repeatedly with metallic magnesium, he succeeded in producing a gas that became denser as the operation proceeded, and turned out to be decidedly different from nitrogen itself. At the same time, Lord Rayleigh solved the problem of separating nitrogen from a possible other gas by the repetition of an experiment devised by Cavendish a hundred years earlier. Both these excellent investigators combined for joint continuation of this work, which led to the discovery of argon, the first type of a new class of elements.

But when an element of a new type had been found, the periodic law immediately suggested the existence of a number of other elements of the same type. Thus Ramsay succeeded in a short time in discovering the element helium, belonging to the same group, in certain rare minerals. An incidental occupation with a liter of liquid air, then first made in London by Hampson, led shortly afterward to the discovery of three further elements of the same type—neon, krypton, and xenon—which were separated from each other and described, using in many cases quite novel methods of determining their properties. Thus while other discoverers were satisfied with single new elements, Ramsay discovered a whole class of elementary substances.

Then when in 1896 Becquerel demonstrated during his stay in Paris his newly discovered dark rays of uranium from which later the discovery of radium resulted, Ramsay showed the keenest interest, and undertook in his own laboratory an investigation of these phenomena.

This work led up to the greatest discovery made by our great investigator, the discovery of the real transmutation of one element into another. The gaseous emanation of radium, which at first had behaved as an entirely new body, showed after some time the lines of helium, and, finally, it was definitely proved that radium in its spontaneous decomposition produced helium in a perfectly regular way. If Ramsay had not come to know helium beforehand as his own child, so to speak, and if he had not, in the course of his work on rare gases, acquired the skill of working with almost immeasurably small quantities of such substances, he would probably not have succeeded in this capital discovery, which placed him among the very first chemical discoverers.

Following upon this work, Sir William Ramsay originated a series of other investigations, some of which are not yet finished, and cannot therefore be dealt with in this place, more especially as he is still at an age at which we may expect great and manifold achievements from him which preclude a final judgment upon his work.

But it may be possible to describe the general type to which Sir William Ramsay belongs as a discoverer. It has already been said that he undoubtedly belongs to the "romantic" type, working with an unusual speed of reaction, and marked by rapid and various productions. The marked peculiarity of this type of investigators, which enables them to train a great number of budding talents and to spur them to extraordinary efforts, has been brilliantly brought out. We may regard the physico-chemical school of Sir William Ramsay as the most important chemical school of his country for a large number of years. He has not been spared the fate of the "romantic" school, inasmuch as he has on occasion made an error in his discoveries. When the unheard-of number of new elements derived from the air rattled down upon the astonished world of chemists, one of these elements, which had been given the name metargon, on account of its similarity with argon, turned out to be carbon monoxide, which had entered the gases by an impurity in the phosphorus. This error did not do much damage, especially since, as Sir William Ramsay remarks himself, there is always in such a case a large number of good friends who hasten to point out and correct such inaccuracy.

Here we have a life in which merit and good fortune have combined as they rarely do. No external difficulties have stood in the way of the straight-line development of the growing spirit, and the acknowledgments of his contemporaries have crowned his great merits soon enough to give his life the benefit of such stimulus. Thus he has come to be one of the great *international* investigators, known wherever science is cultivated. If we add that Sir William personally belongs to those unassuming and agreeable figures such as can only be found in the small circle of the front-rank men of science, and that his domestic fate, though not free from occasional cares, has given him a more than average degree of contentment, we have stated the conditions which lead us to expect that his sixtieth year of life, which he has recently completed, will not by any means mark the close of an unusually rich and fruitful life's work.

The Sources of Energy Available to Man*

Some of Our Possible Supplies As Yet Untapped

By Prof. J. A. Fleming, D.Sc., F.R.S.

What sources of energy are available to mankind, and how do we stand if we attempt roughly to take stock?

In approaching the consideration of this subject the first thing which strikes us is the enormous energy in nature which is unavailable to us, at least at present.

The Energy of the Earth.

Consider, for instance, the energy involved in the earth's motion, both orbital and rotational. The earth flies along in its orbit with a velocity of about twenty miles per second, or 1,200 times that of an express train. Also it rotates in twenty-four hours. It has, therefore, energy of rotation measured by one half $I\,w^2$, where I is its moment of inertia and w its angular velocity and also energy of motion represented by one half MV^2 where M is its mass and V its orbital velocity.

The moment of inertia of a sphere round an axis is equal to 2/5 of its mass multiplied by the square of its radius. Taking the foot, pound and second as units, it is easily found that the rotational energy of the earth is 3/16 10^{30} foot-pounds, or a hundred thousand million billion horse-power hours ($=10^{23}$ horse-power hours). But the orbital energy or energy of motion in its orbit is ten thousand times greater ($=10^{27}$ horse-power hours).

The earth, therefore, is a great fly-wheel which, in virtue of its diurnal rotation, has this enormous energy stored up in it. Suppose we could in some way or other slow down its rotation so as to make the day just five minutes longer, and give us all five minutes more in bed. I do not think it would give rise to any great inconvenience. This would decrease the earth's angular velocity by about 1/3 of 1 per cent, and decrease the angular energy by about 2/3 of 1 per cent, or say by 1/150 part. If then we could capture and store up the difference in the rotational energy in the two cases, it would give us about six million billion horse-power hours, or a billion horse-power for seventy thousand years. The energy we can obtain by the combustion of all the one thousand million tons of coal at present raised per year, sinks into significance compared with the enormous energy which would be set free by an almost imperceptible lengthening of the earth's diurnal time of rotation. As matter of fact the tidal friction due to motion of the tide-wave round the earth is reducing its speed of rotation, but only by a small fraction of a second per century. Since our earth is one of the smaller planets, these figures give us some

*Introductory Lecture to the Engineering Classes at University College, London.

faint conception of the colossal energy associated with the axial and orbital rotations of all the planets, and when we add to that the energy of axial and progressive motion of the sun, the mass of which is far greater than that of all the planets taken together, we see that the kinetic energy which is represented by the motions of the solar system is something far beyond the grasp of our minds to appreciate, even although it may be set down easily in arithmetic form.

Solar Radiation.

Another case of apparently illimitable power which is captured only in small degree is that of the solar radiation. Nevertheless it is the original source of nearly all our available energy.

A very important constant in cosmical physics is the so-called "solar constant." This means the heat delivered per minute by solar radiation to one square centimeter of surface held normally to the sun's rays and corrected for atmospheric absorption. The best results give two gramme calories per minute per square centimeter, or nearly *one million gramme calories* per year per square centimeter. In other words, on each square centimeter 8.4 joules or 6.3 foot-pounds of energy would be expended per minute. This is equal to 1.6 horse-power per square yard, or 7,000 horse-power per acre. As a matter of fact, owing to atmospheric absorption and clouds and the varying inclination of the sun's rays, experiment shows that for Central Europe only about 50,000-gramme calories are received per year per square centimeter. If there were no absorption the earth would receive 250×10^{12} horse-power. Prof. Very has calculated that 100 square meters receiving per annum solar energy, actually receive as follows:

Central Europe, 4 to 6×10^6 kilowatt-hours, or B.T.U.
North, U. S. A., 5 to $7\frac{1}{2} \times 10^6$ kilowatt-hours, or B.T.U.
S. W., U. S. A., 10 to 15×10^6 kilowatt-hours, or B.T.U.

The earth receives only two thousand millionth part of all the energy sent out from the sun. Hence it is easy to show that the total power emitted by the sun is one half billion billion horse-power. Hence the actual amount absorbed at the earth's surface is only about 4 to 10 per cent of the solar delivered. From the value of the solar constant it can be shown that the solar radiation is equivalent to 80,000 horse-power per square yard of the sun's surface. If, therefore, the sun were a furnace burning coal it would have to be supplied with seven tons of coal per square yard per hour to produce by complete combustion the output of energy as regards mere quantity of heat, though it could not produce the actual solar temperature. All but an insignificant fraction of this enormous energy output ever reaches the earth. Of that fraction which does reach it all but an extremely small part appears to be wasted. Nature seems to be inexpressibly extravagant in scattering energy through space or storing it up in inaccessible places, but the amount of it which we can actually control, transform and utilize, is remarkably small. Nevertheless, out of that small fraction of solar energy we have received or do receive nearly all our present energy stores have been produced.

If, however, we endeavor to classify all those sources which either are available now or perhaps may be available to mankind in consequence of future advances in scientific knowledge, we find we can arrange them in four great classes as follows:

1. Food-stuffs and all materials which are combustible; for example, wood, coal, peat, oil, natural gas and such organic combustibles as oils and alcohols of various kinds which can be prepared from plants.

2. Sources of kinetic energy such as wind, waterfalls and rivers, or moving water generally, and sources of potential energy, such as lakes at a level higher than the sea. Tidal energy may be included in this class, though really derived from the earth's energy of rotation.

3. Solar radiation or direct-radiant heat. Volcanic or subterranean heat.

4. Energy stored up in atomic structures and released in radio-active changes. The utilization of this is only remotely possible.

There may be some other small sources of energy due to oxidizable or combustible materials, such as sulphur, native metals, bitumen deposits, which have small utility.

The energy sources in Classes 3 and 4 have scarcely yet been tapped but as we shall see are enormous in amount.

The Energy of Food and of Combustibles.

The energy sources in Class I depend essentially upon the presence of oxygen in our atmosphere. If all the oxygen were suddenly to escape from the earth's atmosphere these sources would cease to represent available energy.

As we chiefly require our energy for creating kinetic energy in the form of moving bodies or to expend it in producing potential energy as in lifting up masses of matter in building, we have in addition to possessing various sources of energy to provide ourselves with suitable transforming devices which shall create the necessary transformations of energy. Such a device is usually called an engine. The oldest kind of engine employed by man is man himself, or some other man in the form of a slave, and the subsequently domesticated animals, such as the horse, ox, elephant, camel or dog. The animal engine is supplied with potential energy in the form of food and air, and will then transform some of it into external mechanical work by lifting weights or setting in motion heavy bodies. Hence an initial source of energy is found in the various food materials. Every kind of food-stuff has a certain energy value which may be determined by burning it completely in a calorimeter. The result may be expressed either in units of heat, such as the calorie large or small, the British thermal unit, or better still in foot-pounds per pound of edible. It is convenient to remember that the so-called large calorie or energy required to raise 1 kilogramme of water 1 deg. Cent. at or near 15 deg. Cent., is equal to 3,085 or nearly 3,100 foot-pounds. The human body can, however, only appropriate a portion of the total energy value of any given food. It is stated in works on dietetics that 1 pound of beef eaten by a man supplies his system with energy equal to about 3,000,000 foot-pounds, 1 pound of white bread with 3,600,000 foot-pounds, 1 pound of cheese with 5,700,000 foot-pounds. An ordinary helping of meat (say beef) and potatoes represents an energy donation of about 1,000,000 foot-pounds given to the body.

A full-grown man doing hard muscular work requires from 25 to 40 ounces of food per day, according to climate and habit, reckoned dry, apart from the necessary water which is present in a considerable quantity in the food as eaten. This food must be taken partly in the form of protein, partly as fat, and partly as carbohydrates, and the total energy extractable from this twenty-five ounces by the human body is equivalent to about 3,000 large calories, or from nine to ten million foot-pounds. This energy is partly used in performing the internal work of the body and in supplying the heat lost and latent heat of vaporization and partly can be recovered as external work. It is doubtful whether any man can continuously perform muscular work equal to 1 horse-power hour per day, or 2,000,000 foot-pounds of mechanical work per diem. Probably not, as a rule, half or a quarter of one horse-power hour, or say 500,000 foot-pounds can be done as a regular thing. This is equivalent to lifting his own weight, say 140 pounds (3,571 feet high), say to the top of Ben Nevis. It is estimated thus about 6,000,000 foot-pounds are expended each day in keeping the circulation, respiration and digestive organs in motion. Also that if a man is called upon to do, say 700,000 foot-pounds of external mechanical work, the body must provide in addition another 3,500,000 foot-pounds, which is thrown off as heat due to the exertion.

Hence apart from the internal work required to keep the bodily machine going the efficiency for external work is about 20 per cent, which is more than the steam engine but less than that of the best internal combustion engines. The human body is, in fact, an internal combustion engine which burns (not oil) but food of some kind more or less imperfectly. But there is a steady stand-by energy consumption of some five or six million foot-pounds. Nevertheless this human engine in the form of slave labor was for long ages the only engine, in conjunction with similar animal engines, of transforming the energy of combustion of food-stuffs into mechanical work of various kinds, and we may say that even now it is one of the most common forms of engine. It was supplemented at best by a few rudimentary forms of wind engine or windmill, and watermill or engine, in performing such work as pumping, grinding corn, or raising weights.

The Steam Engine.

The steam engine and boiler are far from being an efficient means of transforming the potential energy of coal and air into kinetic-energy of motion of masses. A pound of good coal, when completely burnt, gives heat equal to about fourteen thousand British thermal units, equivalent nearly to ten or eleven million foot-pounds. The best engines and boilers do not enable us to obtain from it much more than one or one and one half million foot-pounds of external mechanical work. Part of this inefficiency is due to the essential properties of the working fluid, viz., steam, and to its relatively high condensing temperature, which in accordance with the second law of thermodynamics puts a limit on the fraction of the heat taken from the source which we can convert into work. The other cause is the unavoidable and large heat losses owing to the surface exposed by boiler, steam pipes and cylinders, and losses in products of combustion. Then further there are special disadvantages or difficulties involved in handling and storing the bulky dirty combustible coal, which at most has a total calorific energy of 280 horse-power hours per cubic foot of coal in the lump, and not more than 30 to 40 horse-power hours of this can be extracted by present methods in mechanical form. Hence, although the steam engine held sway as the chief heat engine of the nineteenth century, the invention of the internal combustion engine in which the fuel, gaseous or liquid, is burnt in the engine cylinder or closely adjacent chamber and used to create an explosion, has been the beginning of a new era.

The Internal Combustion Engine.

The modern internal combustion engine is more efficient as a thermo-mechanical machine than the steam engine, transforming a greater fraction of the total calorific energy of the fuel into mechanical energy. As much as 25 to perhaps 30 per cent of the whole energy of the fuel is yielded as mechanical work even in comparatively small engines. An interesting event in this connection was the invention of the Diesel engine, in which all necessity for electric ignition of the explosive mixture of air and oil vapor is obviated, and also the use of a highly volatile oil or spirit.

Coal Distillates as a Source of Power.

For those countries like Norway, Switzerland and Canada, where coal is dear and waterfalls numerous, the question of competition with coal does not arise, but for Great Britain the basis of comparison is the cost of power obtained as at present by the combustion of raw coal. The important question is, therefore, whether we can with advantage gradually substitute for the steam engine and boiler burning raw coal in the furnace the employment of internal combustion engines using oil distilled from coal or else some form of producer-gas, or combinations of oil, gas and steam engines, consistently with capital outlay on plant which shall enable us to obtain more energy from a ton of coal than we do at present, and with accompanying financial advantage.

A letter recently appeared in *The Times'* Engineering Supplement, from Mr. Gilbert R. Redgrave, stating that distillation of coal at a lower temperature than is usual with coke ovens will reduce the quantity of gas evolved but increase that of the tar oil from which a good fuel can be prepared available for use for the production of power. To be economical there must be no waste products. It is clear, however, that a new era is about to rise in which the present use of raw coal will be disfavored. Nevertheless, it will remain the chief source of British energy.

The present output of coal in the world is, I believe, about eleven hundred or twelve hundred million tons a year, and that of oil from forty to sixty million tons. Hence, even though one ton of oil can in internal combustion engines generate three or four times the power that one ton of coal used in the ordinary way with steam engine and boiler can give, it is clearly seen that oil is a long way from displacing coal as a prime source of energy.

There is still another method in which the more economical use of coal for power generating may, perhaps, be developed, viz., in the coal engine of Mr. A. M. Low. In this case coal in a finely divided form is led from a hopper along pipes in which it is heated and when mixed with air gives an explosive mixture. Steam can also be used jointly with the explosive vapor. The heat generated by the explosions is caused to heat the incoming fuel to volatilization. Hence, the process is, to some extent, regenerative.

Experiments with a 100 horse-power engine have shown an efficiency of 1 horse-power per half pound of coal per hour. The experiment has been tried of using in place of vaporized or atomized heavy oils finely divided coal directly in a Diesel internal combustion engine. The explosive character of coal dust and air or even flour dust and air are well known.

The difficulty which occurs is due to the accumulation of ash in the cylinder or combustion space. The future of the gas turbine is a subject which was discussed by Dr. Dugald Clerk, who is a great authority on this subject, at Dundee, at the British Association, and is of very considerable interest. It affords another possibility for utilization of products of coal distillation.

The problem, therefore, is the establishment on a much larger scale than anything yet attempted of power stations in contiguity to our coal mines in which power is generated by some form of large internal combustion engines utilizing a heavy coal oil or coal gas assisted, perhaps, by steam engines utilizing coke as fuel, the energy being transmitted electrically at high tension to the centers of consumption.

One of the difficulties at present is the small power, relatively speaking, of the internal combustion engines which yet can be built as compared with steam engines.

It is now quite feasible to transmit at electric pressures up to 100,000 or even 150,000 volts, and at 75,000 volts a current of only 1 ampere conveys 100 horse-power. There is nothing impossible to present-day engineering in the proposal to generate 50,000 horse-power in the form of electric current at 75,000 volts pressure, and distribute it in different directions by suitable overhead conductors over areas of 100 square miles.

Wind and Tidal Power.

In certain regions of the earth there are regular winds which blow for months at a time and more might be done to utilize them. The irregularity in force is, however, the chief obstacle to usage except for pumping up water to reservoirs.

As regards the utilization of tides, it is a very popular subject for speculation but the very large reservoir

area and constructions necessary are likely to make it anything but a free gift.

The immense extension of hydro-electric stations for utilizing ordinary waterfalls or high level water of late years in Switzerland, Norway, and Canada are well known. It has been estimated that there is available in Sweden 3,800,000 horse-power, in Norway 4,800,000 horse-power, and in Canada 17,000,000 horse-power in water-power. In Canada about 1,000,000 horse-power is now utilized and in Sweden and Norway about 1,000,000, but Great Britain, is unfortunately, deficient in this natural source of power.

The Direct Use of Solar Radiation.

As regards the direct use of sun power or sun heat, an interesting attempt has been made in the solar engine of Mr. Shuman of Tacony in Philadelphia. He allows the sun heat on hot, bright days to heat water placed in pipes in shallow trenches covered with glass plates and employs this hot water to actuate a turbine worked with a vacuum in the rotor chamber so that 10 per cent of the nearly boiling water explodes into steam and ejects the rest against the rotor, thus producing mechanical power. The experiments show that an engine of 1 horse-power required 160 square feet of absorber surface. This shows that only a small fraction of the incident solar energy is really converted to mechanical power. It may be even better to utilize solar light and heat to force growth of vegetables from which oil or alcohol can be procured to use in internal combustion engines of the Diesel type.

Atomic Energy.

I turn, however, in conclusion to consider a possible source of energy as yet quite untapped, but which is almost limitless in amount and perhaps not quite beyond human ability to appropriate in some degree. I mean the energy locked up in atoms of matter in the form of structural potential energy. Until 1896 it was generally assumed that the eighty or so different kinds of atoms of matter were perfectly incapable of being broken up or altered. Clerk Maxwell had spoken of them in a famous lecture as the "foundation stones of the material universe," which remain, as he said, "unbroken and unworn." But at that date Becquerel made the initial discovery that minerals containing uranium had peculiar properties of affecting a photographic plate. M. and Mme. Curie followed up this discovery with astonishing skill, and ended by isolating from uranium ores the new element, radium, having startling properties. These are chiefly as follows: Compounds of radium produce brilliant fluorescence when held near certain substances such as platinocyanides of barium, the mineral willemite, and other bodies such as zinc sulphide and diamond. Secondly, they cause the air near them to become conductive so that a charged electroscope loses its charge when radium compounds are brought near it. Thirdly, they maintain themselves continuously at a higher temperature than surrounding bodies in such fashion as to show that each gramme of radium emits 100 gramme-calories of heat per hour. Lastly, they emit continuously a torrent of atoms of helium, of electrons and of ether waves, which are called respectively the α, β and γ radiation.

The researches of numerous physicists have made it clear that the explanation which best fits the facts of these phenomena is that the radium atoms are in a continual state of disruption. It may be compared with a magazine full of cartridges which from some cause or other are in an unstable state. Every now and again a cartridge explodes and fires off its bullet. In the case of the radium atom the bullets are either particles the size of atoms, probably of helium, or still smaller masses called electrons. The helium atoms or α particles are shot off with a velocity equal to about 1/18 or 1/20 that of light and the electrons with a velocity approaching that of light. The α particles are charged with positive electricity and the electrons carry a negative charge. These α particles or helium atoms are not all ejected at once. The first change which takes place when a radium atom fires off or expels one atom of helium is that the remainder becomes a kind of nonvalent gas resembling in its general chemical behavior the neutral atmospheric gases argon, neon, etc., discovered by Sir William Ramsay. This gas is called the emanation. The emanation in turn loses more atoms of helium and becomes converted into substances called radium *A*, *B*, *C*, *D*, *E*, and *F*. Radium itself is believed to be produced in the same manner from uranium, and the final product obtained from radium when all these changes are complete is very probably lead. It appears not improbable that an atom of uranium is a complicated structure from which, when 8 atoms of helium have been expelled, the residue is an atom of lead. Hence, the dreams of the alchemists have in a sense come true, only it is not lead transformed into gold but uranium which is transformed into lead. It would take far too much time to tell the whole story of these sensational discoveries. What is of importance to us now is the energy evolved in these changes. It has been shown that 4 parts in 10,000 of any mass of radium disintegrates per year, and hence the average life of a radium atom must be 2,500 years. Since 1 gramme of radium evolves 100 gramme calories per hour, a gramme of radium must give out during its whole life energy equal to that produced by the combustion of ¼ of a ton of coal.

Now, ¼ ton is nearly 250,000 grammes. Hence, the potential energy of radium is a quarter of a million times greater than that of an equal mass of coal. We must, therefore, regard the atoms of these radio-active elements, uranium, thorium, radium, and actinium, as structures which are gradually breaking up and evolving heat. At each rupture they give out energy just as when a house falls down the potential energy represented by the elevated masses of brick or stone is converted into heat. This discovery has greatly modified our views as to the cause of solar and terrestrial temperature. Until lately the most probable hypothesis as to the cause of solar heat was that it was due to a continual shrinking of the sun's diameter, compressing materials and raising their temperature. It was calculated that a shrinkage of 40 miles in every thousand years in the sun's diameter or something of the order of 6 inches a day (an amount quite imperceptible to measurement) would account for the solar radiation. Moreover, the earth was considered to be continually cooling, and from data obtained by the temperature gradient in the earth's crust it was asserted that the earth must have been in a state of incandescence or at least hotter than boiling water not much more than one hundred million years ago. But the geologists always declared that this time was not sufficient to allow of the development of the earth to its present condition, and to afford time for evolution to produce the flora and fauna now found on it. Experiments by Prof. Jolly, Prof. Strutt, and others, have shown, however, that a large number of the earth crust materials, if not all, contain radium, roughly speaking, from two to twenty-five parts in a billion, by weight. If this amount were distributed uniformly through the globe it would not only suffice to account for all the terrestrial heat lost, but at the same time would even cause the earth's temperature to be rising.

In the same way Rutherford has calculated that if there were present in the sun two and one half parts, by weight, of radium in a million of other matter it would suffice to maintain the present rate of radiation by the sun.

Hence, although the actual amounts of radium already extracted from uranium ores is small, probably not more than an ounce or even half an ounce altogether has ever been prepared, yet, nevertheless, the total amount contained in the whole earth may even total up to one thousand million tons, which is equivalent in heat-producing power to two hundred and fifty billion tons of coal. A problem of surpassing interest then in connection with human progress is whether we shall be able to tap this enormous source of energy in any way. At the present moment we have not any idea of how this may be done. A hint as to a possible solution of the problem may be obtained as follows: It is now pretty generally recognized that an atom is a complicated structure, a sort of solar system in miniature composed of revolving electrons. It may be possible to break down the structure by the action of impulses due to concentrated electric-waves of the right period, setting up vibration, which are resonant with some natural period of the atom, just as it is possible to break down a suspension bridge by a number of men jumping on it in time with its natural period of oscillation. If, then, the atom were to break down the energy liberated might be far greater than that applied to it in the form of the resonant impulses. All this, however, is a long way from realizations. As far as concerns the sources of energy which are available at present, the moral to be drawn is that they are not inexhaustible.

Our stores of coal and oil are large but not indefinite. Water-power and food will continue as long as the sun shines on us, but population and energy demands ever increase.

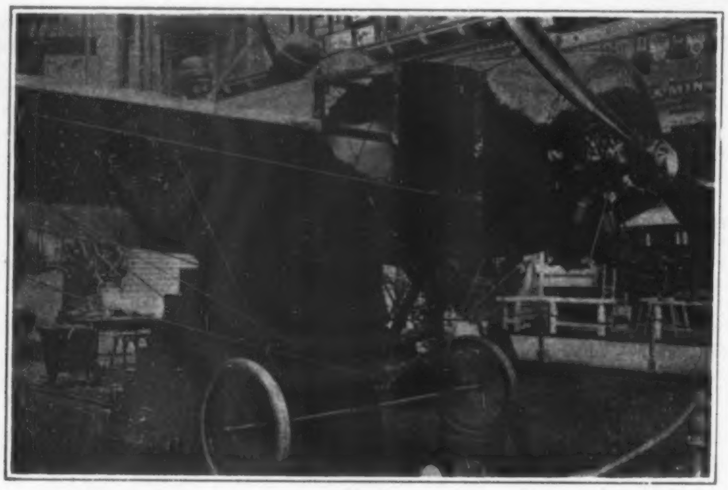
This slight sketch of the position of our energy problem will be sufficient to show you that while we are no doubt a long way yet from an energy famine, the world has arrived at a stage in which we cannot afford to treat our available sources at all wastefully. Hence, the engineer is more than ever the arbiter of the world's destinies. The fate of population, and indeed of civilization itself, depends a great deal more on the engineer than it does on most of our statesmen and politicians with their quack or doubtful remedies for human ills. Hence, there is a wide field for useful work in all branches of engineering, provided we bring to its prosecution initiative, originality and a high scientific training.

Ships With Corrugated Hull-Plating

The Ericsson design of ship, having the shell-plating arranged with two longitudinal corrugations along the side between the water-line and the turn of the bilge, is steadily growing in favor. The first ship—the "Monitoria"—built, like her successors, by Messrs. Osbourne, Graham & Co., Sunderland, has been running for three years; the second—the "Hyltonia"—for one year; the third was launched in May last; the fourth in July; and two others are in course of construction; while a seventh is being built in Norway. The results of the working of the two completed ships, and the confidence disclosed in ordering the others, justify some examination of the claims set up for the design, and it was not, therefore, inappropriate that these should be dealt with in a paper recently read at the Royal United Service Institution by Capt. G. S. MacIlwaine, R. N. (retired). He had made several voyages in one of the ships with a view to forming an independent judgment of the merits of the case, and the aim of his paper was to secure that the system should be considered by the Admiralty. The points he put forward were: increased strength, specially called for in the case of destroyers; greater resistance to penetration by projectiles, obtainable even in the case of armored ships, especially when the ship was rolling in a heavy sea during action; and higher propeller efficiency, consequent on superior stream-lines due to the corrugations. The Admiralty are no doubt fully cognizant of the potentialities of the design; but Capt. MacIlwaine's statement will be useful to Navy officials as well as to shipowners.

The "Hyltonia" is representative of the system. She is 279 feet long between perpendiculars, 39 feet 10 inches beam, 18 feet draught, with 3 feet freeboard, and carrying 3,340 tons dead-weight she displaces 4,614 tons. The net registered tonnage is 1,149 tons. There are, in her case, two corrugations fore and aft, the width from the top of the upper corrugation to the bottom of the lower being 13 feet 3 inches, and from the inner edge of the frames the corrugations project 22 inches. Forward and aft the corrugations taper to merge into the normal lines of the hull. Before deciding to build the ship, the owners carried out some tests with models in a tank on Caw's pendulum system. Models of plain and corrugated ships, without other variants, were floated and attached pivotally to a pendulum first held at a known angle to the vertical by the model being secured in the tank to a cord. By the burning of the cord the model was gently released, and the amplitude of swing of the pendulum determined the comparative resistances of models. The results suggested possibilities of "a reduction in effective horse-power of from 14 to 23 per cent." The claim made is that "the space between the corrugations seems to act as a conduit pipe supplying the screw, which, in its turn, seems almost to play the part of a pump drawing a solid body of water along the ship's side in which to work." In other words, that the stream-lines are better, water being less disturbed. Capt. MacIlwaine said that the blades of the propeller could be seen rotating at all speeds as clearly as through crystal. The data of actual performances showed that when the corrugations were fully immersed the slip of the propeller averaged less than 2 per cent, as against 13 per cent for ordinarily plated ships of the same design. The average revolutions in the corrugated ship were 58, the power 630 indicated horse-power, the normal speed about 9 knots, and the fuel consumption, when loaded, 10.8 tons of Lancashire coal per day. For the same duty with the plain plated ship the power was 700 to 750 indicated horse-power, and the consumption 12 tons per day.

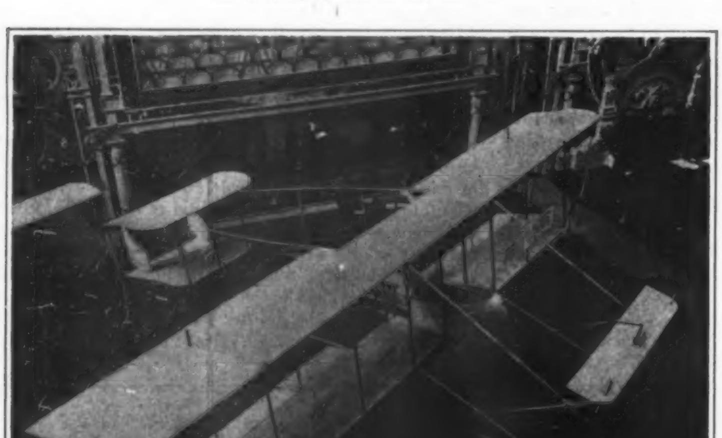
It was claimed, too, that the corrugations add to strength. In the "Hyltonia" every alternate frame was left out under the highest classification of the British Corporation, so that the frames were 48 inches apart, as compared with 23½ inches in ordinary ships of the same size; this, and the absence of stringers, effected a saving of 50 tons in weight. Again, as tonnage measurement is from the inside of the framing, there is increased cargo-space without tonnage dues being exacted, for the space given by bulging out in the corrugated plates is not reckoned. The same considerations facilitate inspection and the handling of cargo. Increased steadiness at sea and greater stability were also claimed, and results were given of sea-behavior. In one voyage the deck portion of a cargo of timber was 43 per cent of the whole, the average height of the deck cargo being 18 feet; on another occasion the figures were 45 per cent and 19 feet, respectively, 428 tons of water ballast being carried in the tanks. It was also contended that vibration was reduced, and steering made easier, while the constructional cost was about the same.—*Engineering*.



Morane-Saulnier Monoplane, With Observation Window at the Side.

The 1912 Model of the Nieuport Monoplane.

The Savary Stand at the Salon.



Maurice Farman Biplane.

Novelties at the ris A

A Fine Exhibition Representative he Prese

LAST year's Salon was somewhat of a revelation for the number of machines displayed. Then there were something like 43 on exhibition. This year the number has sprung up to 77, of which about 27—those machines that are shown in the gallery—belong to the French Army. They, the French government, have joined in the proceedings very considerably, quite indicative of the keen attention that they pay to matters aeronautic. Not only have they lent such a representative collection of their own "avions," but the French Minister of War has taken a large stand where is displayed a whole battery of Delahaye motor lorries, with bodies specially equipped for carrying large stocks of spare parts. And in what better way could the government show the people how completely they are watching over their safety in the air? Every stand has an air of progress and prosperity about it, an effect for which the French constructors have to thank an encouraging government.

From the Salon has vanished the dirigible. Last year there was a complete Astra dirigible suspended from the roof and two or three nacelles were on exhibition. This year the only objects that remind one of the lighter-than-air school are two spherical balloons and two little models of dirigibles—one on the Zodiac, another on the Continental stand.

A newcomer to the Show is the "Aviette." A perfectly hopeless collection of these are foregathered at the Champs Elysées end of the hall.

Hydro-aeroplanes have grown considerably in force since last year. Then there was only one—the Voisin "Canard," a machine which is absent from the Show this year. Now there are no fewer than eleven, seven of them hydro-biplanes, and the rest of the single-decker type. As a class, the hydro-aeroplanes do not seem any too happy, except in the case of the Henry Farman machine and that of the Caudron Brothers. The constructors of the two examples mentioned h each used a type of float which suits, as com appearance, the type of machine. In the mainder, especially in the monoplanes, the f seem unwieldy, and altogether mars an other graceful outline. But, perhaps, this is because are as yet comparatively unused to them.

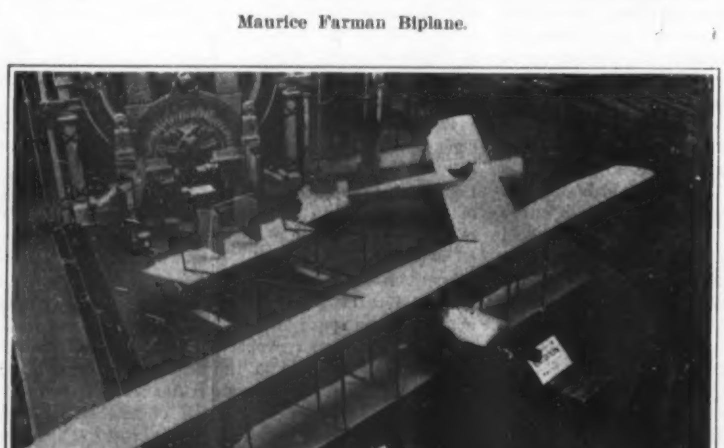
Those hydro-machines in which the float the fuselage are combined in one unit are little more pleasing, for one immediately that such low centers of gravity and head r ance are undesirable. Donnet-Lévêque elimi the center of gravity trouble by putting their gine up high between the planes.

But one other firm, to make their "co stable as a water craft, have placed the m quite low inside the body.

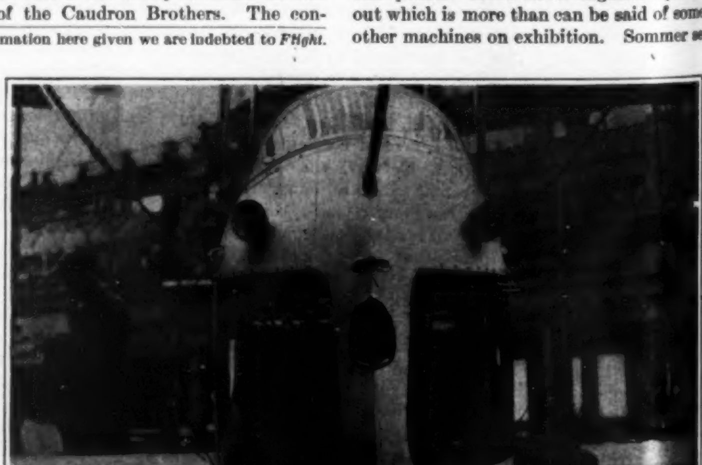
Of the land aeroplanes, monoplanes are, usual, in preponderance. There are 46 m planes as against 20 biplanes. The chief i provements resulting from the past year's w lie in detail design. Here we must certainly the laurel wreath to the Hanriot firm. Their hibit is recognized as the "clou" of the Salon.

M. Pagny, their designer, has excelled him and the Nieuport firm, with whom he was c nected formerly, must be mightily sorry t ever lost his services. They are getting things a fine point on the Hanriot when they provi box containing tools and engine parts just be the pilot's seat; when they so mount the Gn engine that it can be taken clear of the ma inside of 60 seconds; when wings and stabi may be folded back against the fuselage in than five minutes without interfering with adjustment; and when the propeller coupling so designed that it may be urged off its taper turning a nut between the coupling and h *carlingue*. Besides these there are innumera neat points. It is a clever engineer's job thro out which is more than can be said of some of other machines on exhibition. Sommer seem

* For information here given we are indebted to *Flight*.

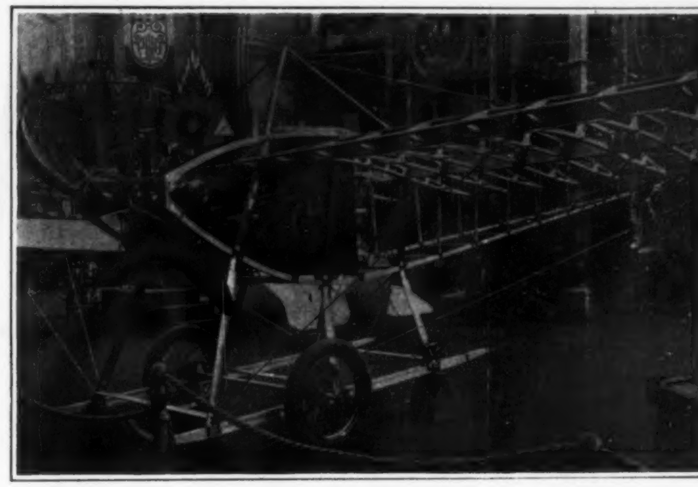


The Caudron Stand.



The Front of the M. Farman Machine Presents a Very Striking Appearance.

Morane-Saulnier Machine, Showing the Renault Motor Partially Exposed.



The Hanriot Monoplane.

ris Aviation Show*

he Present Development of the Art

ave lost himself entirely in the biplane he is howing this year. His last year's model was romising, but his present one—scarcely!

The Nieuport people, too, have not gone forard. Their present chassis is delicate enough, n all conscience. The pilot of their new model ill, if he is not extraordinarily careful, find himelf going tent-pegging. A glance at our sketch f their new landing carriage will set this point lear. Their workmanship, however, is superb.

Henry Farman has undoubtedly gone ahead. His present workmanship is a revelation comared with what he turned out even a year since. Whatever some people delight to say about his roducts, there is no doubt about the fact that hey are extremely popular with those who fly hem. Otherwise, how would there be the deand for them that he has erected such magniicent works to satisfy? He is not showing his monoplane this year.

Louis Breguet's main alteration is in the chasis, which now has four wheels instead of three.

The Caudron Brothers this year are exhibiting their monoplane as well as their hydro-biplane, f which machines, especially the former, they ave every reason to be proud.

Deperdussin is specializing in his "monocoque" design, and probably is not far wrong.

Blériot seems rather restless as regards his anding chassis, albeit very sound as it is. His laminated spring chassis of last year did not surive the Salon. It was extremely neat and pretty, ut it wouldn't stand up to severe service. This year he has an altogether new model. It has a "monocoque" body, cleverly constructed of paper, cork, and fabric, and its chassis is of the single skid type, all steel.

Borel, too, has followed the trend of design toward the "monocoque" in his new 80-horsepower racer.

For the rest, the R.E.P., Besson, Tubavion, Vinot, Savary, and Zodiac, they remain, except for finer detail work, practically the same as they were at the last exhibition.

British manufacturers have, this year, two representatives at the Salon, the enterprising British and Colonial Aeroplane Company, Ltd., and Breguet Aeroplanes, Ltd. The former people are showing Coanda type Bristol monoplanes of the type that figured so well in the British Military Trials, and that have sold so well in Italy and in other countries abroad. The latter have on their stand a biplane such as was flown at Salisbury back in August, but with a different chassis.

BLÉRIOT.

Louis Blériot is showing three models and his 50-horse-power Gnome single-seater, his 70-horse-power Gnome tandem two-seater, and a new model that has not yet been tried out.

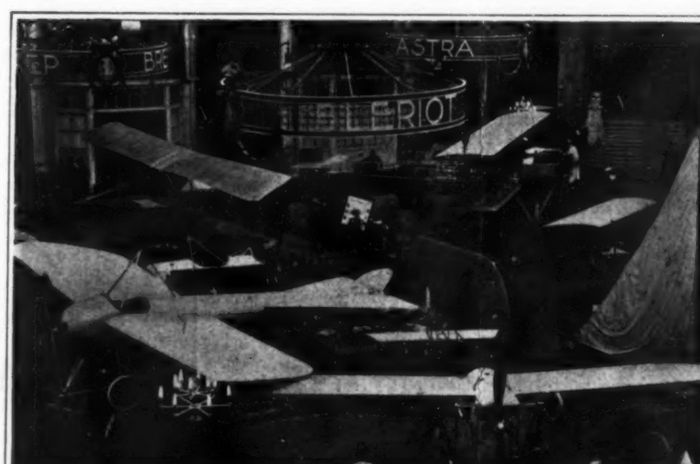
This new machine is of a particularly clear design. The fuselage is of torpedo form, circular in cross section, and sufficiently wide near the front to seat pilot and passenger side by side.

The construction of the fuselage is extremely interesting. It is of the monocoque type and made on a "forme" in the same manner as a boot on a last. Over the "forme" paper is applied and over that pieces of sheet cork.

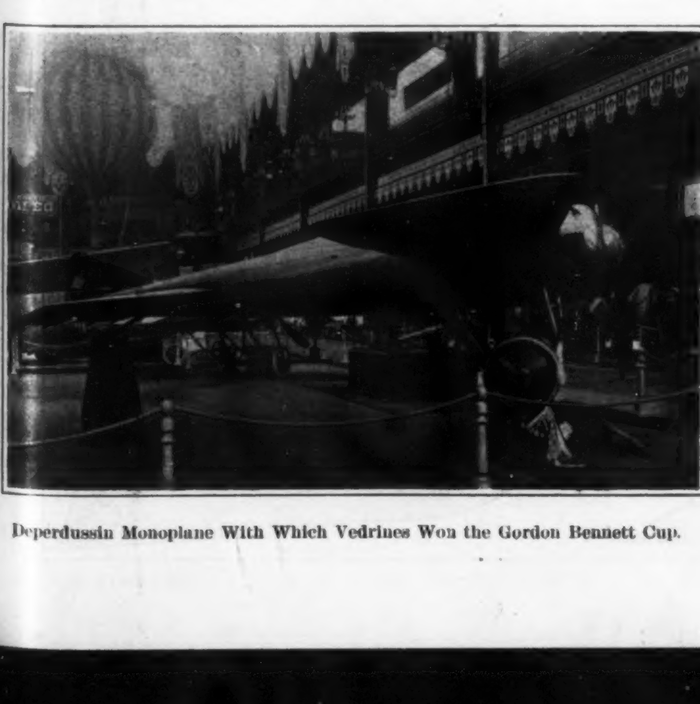
The whole is well glued up together, then covered with fabric and well pasted to prevent the ingress of water. The thickness when completed of this composite skin of paper, cork and fabric is roughly 6 millimeters. In front, where greater strength is required to withstand the strains of the rotary 80-horse-power, the composite skin gives way to chrome steel sheeting. A Levasseur propeller is used.

As we have already said, the chassis has undergone an entire change. The new one, as the sketch shows, is of the single skid variety, preferable because of its low head resistance. It is carried out in steel tubing and the wheels are sprung by oleo-pneumatic springs of special design. From the efficiency of a similar spring, mounted

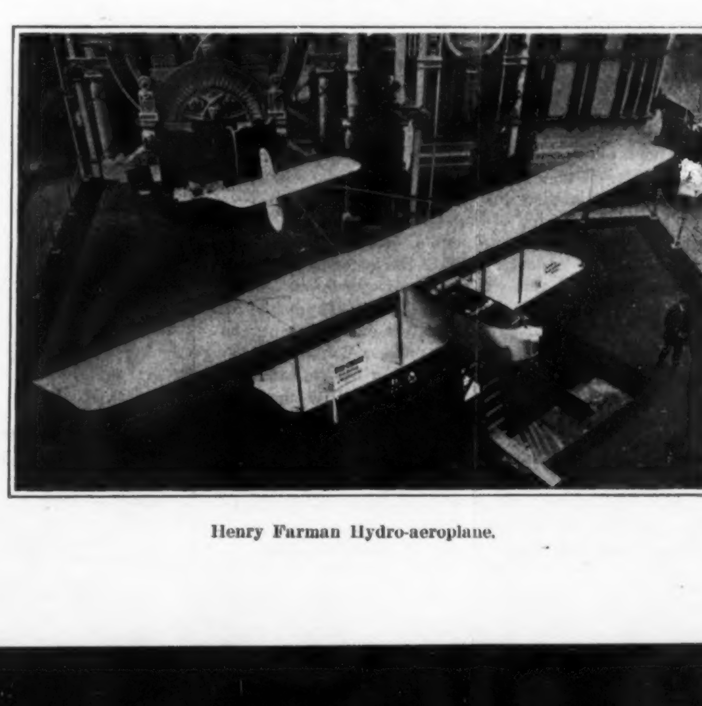
The R. E. P. Hydro-aeroplane.



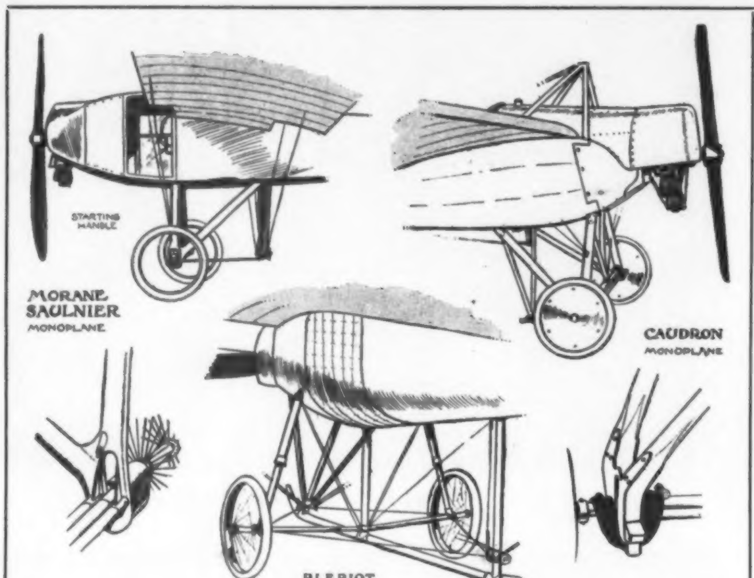
The Blériot Stand.

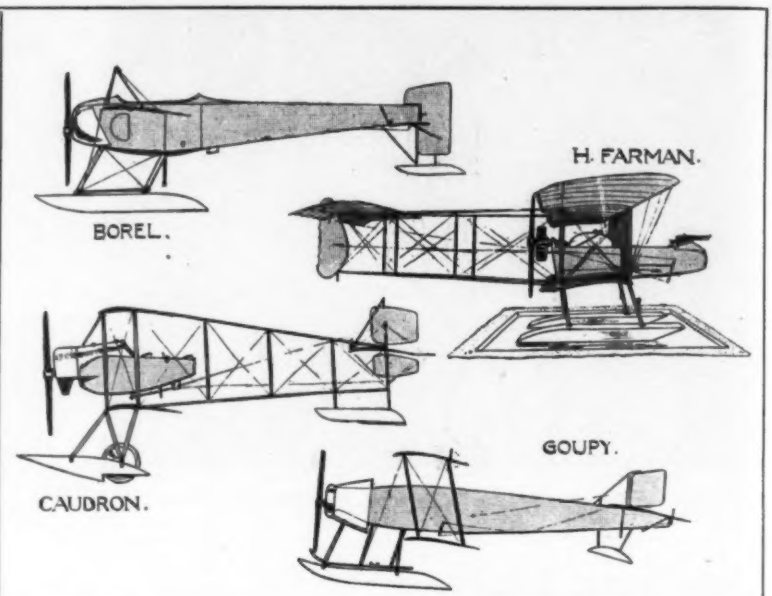


Deperdussin Monoplane With Which Vedrines Won the Gordon Bennett Cup.



Henry Farman Hydro-aeroplane.





in a stand of its own for demonstration purposes, we should think that no great amount of trouble will be experienced with the suspension. Blériot, too, has, on this machine, made use of the floating tail with hinged elevators. The rudder is shaped like a fish tail, and the levers and cables actuating both are carried inside the fuselage. There is no back skid, for the weight of the tail is carried by the rear end of the main skid. A tripod cabane above the cockpit supports the wings through strong steel cables when the machine is stationary, and, when in flight, so Blériot has told us, it sometimes comes in for a bit of top pressure. The wings are of conventional Blériot design and span 12.25 with a chord dimension of 2 meters 25. The supporting area of this new machine is 25 square meters, and its weight, without oil and fuel or passengers, is 375 kilos.

The other two machines on the stand need no description, for those that follow things pretty closely in England know their main characteristics.

There is another object of interest on the stand, and that is the Blériot aeroyacht, a light four-wheeled chassis fitted with a leg-o'-mutton sail which Blériot primarily designed for the amusement of his family when staying at his place at Hardelot *plage*.

BOREL.

Borel's exhibit of three monoplanes, one of them fitted for water flying, is one of the most interesting in the Show. He has a 50 horse-power Gnome single-seater, a racing monocoque with an 80 horse-power Gnome and the hydro-monoplane equipped with a similar motor. We may put aside the single-seater machine for, except for detail improvements here and there, it is no different from the one that Vedrines brought so much into the limelight by his magnificent flying during the earlier part of 1911.

The hydro-monoplane, too, is nothing but an enlarged version of the same machine and fitted with floats. But it has some interesting details. The rear float pivots with the rudder and so comes in useful for steering over the water at slow speed. There is a clever starting arrangement so that the passenger can get the motor going without leaving his seat. From a half-speed engine sprocket extends a shaft which terminates in a wheel just between the passenger's knees. Attached to this wheel is a steel band which, if sharply pulled up, sends the engine through to about three-quarters of a revolution, enough, in most cases, to start it off. This wheel, of course, is fitted with a free-wheel attachment.

Another interesting point is, that alongside each float are to be provided fittings so that a pair of oars may be carried. Rowlocks are to be fitted, too, so that, getting into port, pilot and passenger may clamber down out of their seats, sit themselves on the front of the floats and row up to the landing slip.

The third machine of Borel's is the monocoque, inspired probably by Deperdussin's. Its fuselage is built up in a similar manner to that of the latter machine—in three-ply wood. But whereas the Deperdussin has no framework inside, the shell of the Borel is supported by six longerons, united by circular formers. In front, the 80 horse-power Gnome revolves under a dome, of which a quarter segment is cut away to allow for the sufficient cooling of the motor. Its wings, in which little curvature and little angle of incidence are noticeable, are of the papillon type—they are smaller in chord at the root than at the tip. For the chassis, it consists of two V's of streamlined steel tubing, to the base of which the axle uniting the two disk wheels is strapped by elastic bands. The tail, like the two-seater Morane-Saulnier machine, has no fixed stabilizing surface; it merely has elevators rocking about their approximate centers of pressure. A small vertical fin precedes the rudder. Each wing is stayed on the underside by only two cables, a double one running from one side of the chassis to the opposite wing, and one staying the rear-spar and actuating the warping.

The monocoque has not yet flown, and when it does—which will be as soon as the machine can be got away from the Salon—speeds of over 90 miles an hour are expected.

BRISTOL.

On this stand is a monoplane similar in almost every particular to the one that carried off £1,000 in prizes at the British Military Aviation Trials at Salisbury Plain. The stand is surrounded with people all day long, and they stand and look as if not being able to credit that a firm of British constructors could turn out such a notably fine example of aeroplane construction. No wonder the Bristol people go to the Paris show when they number among their foreign customers such persons as the Mnisters of War of Russia, Germany, Italy, Spain, Turkey, Roumania and Bulgaria.

The machine has somewhat the lines of a submarine with wings. The blunt metallic snout over the Gnome motor and the funnel-like upper cabanes tend to carry out the impression. Throughout it is well and conscientiously built, in perfect keeping with their usual painstaking work.

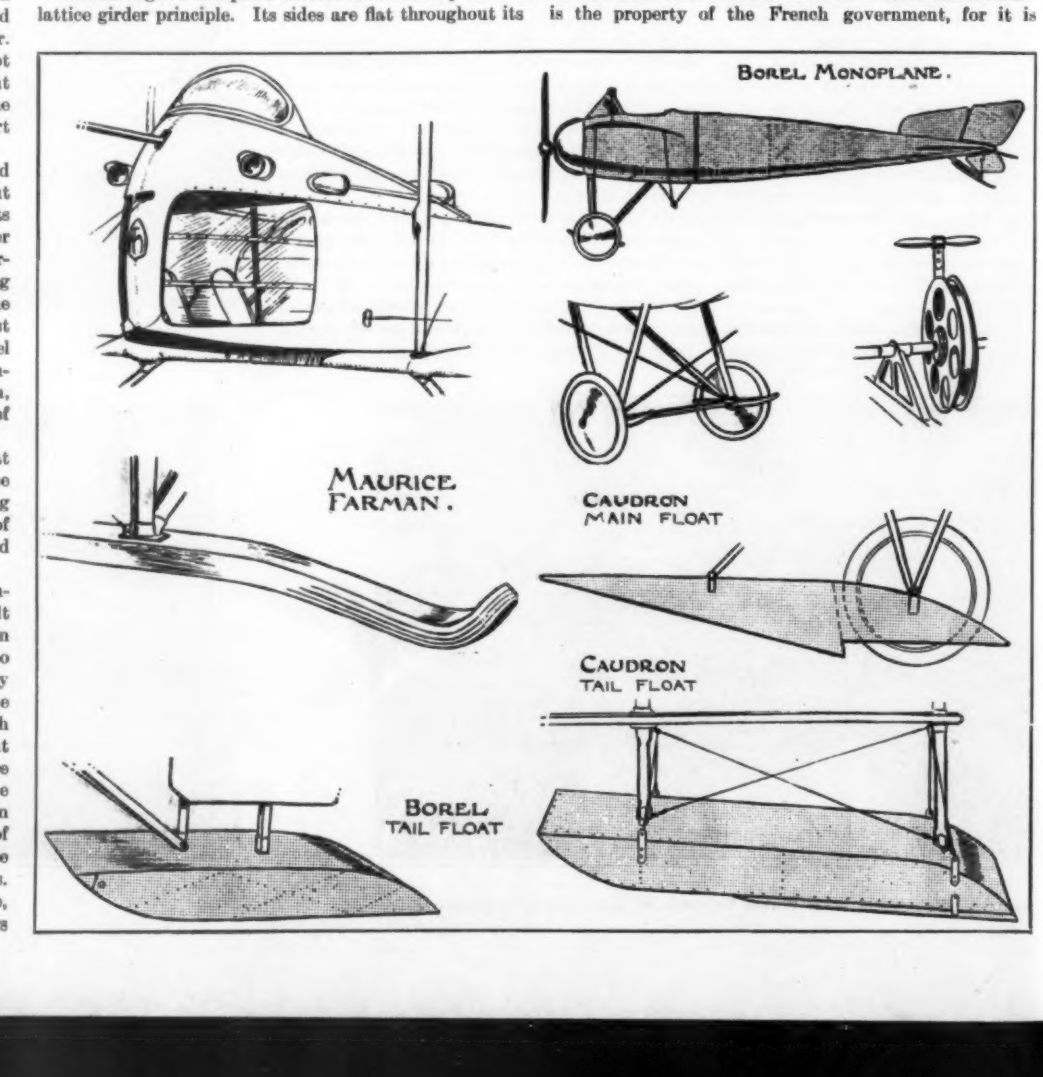
The fueslage is of square section and built up on the lattice girder principle. Its sides are flat throughout its entire length, but the top and bottom are bellied out by the application of aluminium sheeting. An 80 horse-power Gnome motor protrudes from the front, half covered by an aluminium cowl that keeps oil from the pilot and passenger, and that reduces the head resistance of an otherwise unprotected revolving engine. The chassis is at the same time simple, clean and effective, merely two horizontal skids supporting the body by four strong hollow streamlined struts, with a pair of wheels strapped across them by elastic bands. Tusk-like projections extend in front of the skids and carry another pair of wheels, but quite miniature ones, which protect the propeller from damage. The tail is of conventional design. Its disposition may be seen from the little accompanying sketch. Control is arranged in duplicate so that either pilot or passenger, sitting in tandem, may take charge of the machine in flight.

As was announced recently Italy has ordered a batch of twenty of these excellent machines. The latest news indicates that the order is more than likely to be considerably increased.

CAUDRON.

Little need be said of the Caudron exhibit for the monoplane is, except for minor details, exactly the same as the one which Ewen has at Hendon.

The hydro-biplane shown is of the combined wheel and float type that has been adopted by the French Minister of War for use in their colonies. The machine itself is the property of the French government, for it is

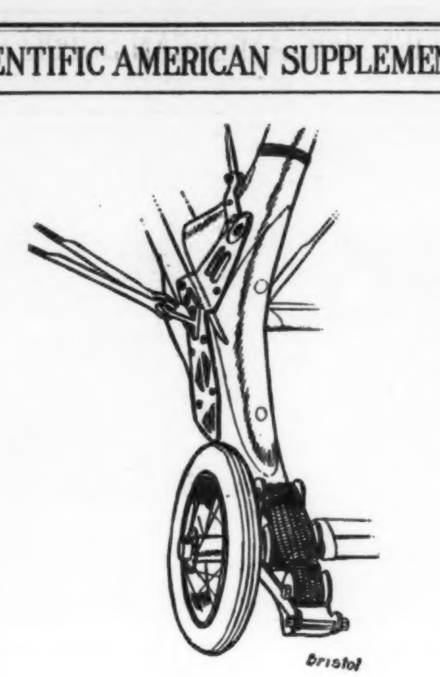


stamped with their official seal on every part. It has much the same characteristics as the Caudrons we have been used to seeing at Hendon, except that the lower tail outriggers have nothing to do with the chassis but are taken from the lower rear wing boom. The rudders too are larger, there being auxiliary rudders below the tail plane. MM. Réné and Gaston Caudron hold a patent in their combined landing gear. The essence of it is the arrangement of the wheel to the rear of the step in the float in which position, they claim, the water does not touch it once the machine is in progress over the surface. There is no springing in the chassis at all—the floats are rigid and the only resiliency at the wheels is that provided by the fat pneumatic tires. The monoplane, as we have already said, is essentially the same except for the changes in the engine cowl and chassis. These are better conveyed by sketches than by words.

HENRY AND MAURICE FARMAN.

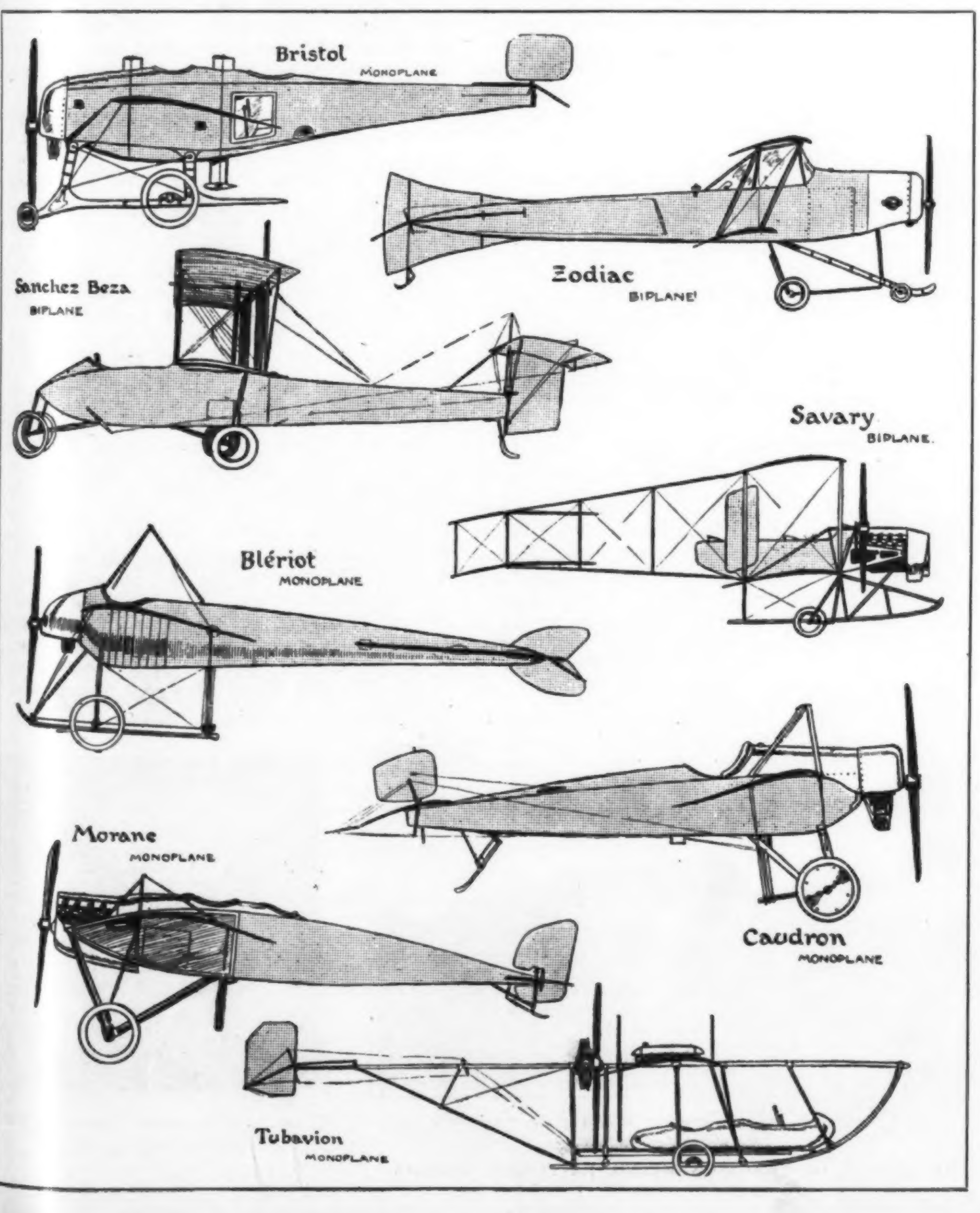
Their workmanship is excellent, and their designs too. The brother Maurice has on his stand a biplane similar in nearly every respect to those that are handled in England by the Aircraft Manufacturing Company, Ltd., of Hendon, and flown by Verrier. It only differs in two points, a more elaborate and highly finished nacelle is fitted, presumably because it is Show time, and the rear part of the landing skids are bent downward to pull the machine up quickly on landing. These two points we illustrate.

Henry Farman's hydro-biplane is easily the prettiest machine of its type in the Salon. It looks good and it is good; and the workmanship throughout would stand examination through a microscope. It maintains the same lines as the biplane of his that has been made familiar by recent description, but it is considerably smaller, and is fitted with a Gnome engine of only 50 horse-power. It is indeed an efficient machine if it succeeds in lifting two persons clear of the water with an engine of such low horse-power. The floats, constructed by Tellier, are just plain narrow pontoons with no step in them, and for them it is claimed that they are considerably more effective in rough seas than those of the wider and shorter variety. Each float is connected to the body of the machine by two simple steel struts, and held rigidly in position by steel bracing. The chassis is not so high and of



course considerably stronger than his earlier ones. Two little port and starboard lights are provided, for they are essential, if the machine is going to be kept out on her moorings all night. Inside the body the pilot and passenger can make themselves as comfortable as they could in their own club's smoking-room. All the upholstery is of leather, and a floor covering of thick carpet completes the snug appearance.

Sitting in front, the passenger has a magnificent view all around him. Before him in this particular machine is mounted a mitrailleuse. Behind sits the pilot controlling the machine with a lever, not such as were fitted to Farman's a year or two back, but a thoroughly neat one, with all its wire connections tucked away inside its mounting out of the way. On a little dashboard in front of him are all his instruments and a pad on which he can scribble down notes.



Contrary to Henry Farman's early practice, the ailerons, which are of large aspect ratio and fitted to the top plane only, are interconnected, so that when one is pulled down the other one rises.

MORANE-SAULNIER.

There are three models shown. Two of them are two-seaters, and one has an 80 horse-power Gnome installed and the other a 70 horse-power Renault. The third monoplane is a single-seater scouting machine fitted with the ever popular 50 horse-power Gnome. In main outline all three are the same and not a great deal different from the single-seater model, with a rigid chassis that was shown last year. There is the important difference that the designers have discovered during the past year, the necessity of fitting some form of springing to the wheels, although, perhaps, they might have got over their difficulty quite well by merely fitting pneumatic tires of such greater diameter than those on last year's rigid chassis. In detail the two-seaters are a great improvement on those shown twelve months back. For instance, the observer on the 80 horse-power Gnome machine has a most complete view both below him, through a hole in the floor, and on either side through windows of triplex glass. In the machine exhibited, dummies occupy the pilot's and passengers' seats. The front dummy, supposedly the observer, is posed with a rifle.

Let us briefly run through the main features. The fuselage is a box girder flattening to a horizontal line at the rear which is the axis on which the elevators turn. On the two-seaters there is no fixed stabilizer surface—simply balanced elevators. That part of the machine is kept clear of the ground by a neat little tail skid. There is no change as regard the wings, they retain the notion of having the trailing longer than the leading edge. An improvement in the 80 Gnome 'bus is that the passenger has before him a starting handle so that the machine may be got going without his leaving his seat. He'll probably have to get out once or twice to inject gasoline, unless he has a mechanic to do it and then the mechanic might as well, while he were about it, give him a "turn over." Still, at times the starting handle will come in quite useful.

TUBAVION.

Although more or less the same in outline as the model shown by Messrs. Ponche and Primard last year, the Tubavion all-metallic monoplane has undergone several minor changes. The monoplane shown at present is a two-seater with a 70 horse-power Gnome installed. Their last year's machine was a single-seater which had its engine, a 45 horse-power Labor Aviation, if we remember correctly, mounted in the underslung body in front of the pilot, whence the drive to the propeller was by shaft and chain. The motor, this year, is back behind the wings and mounted concentrically with the top tube of the fuselage. The skids, almost the only wooden part of the machine, used to run from end to end. They now only extend for the front half.

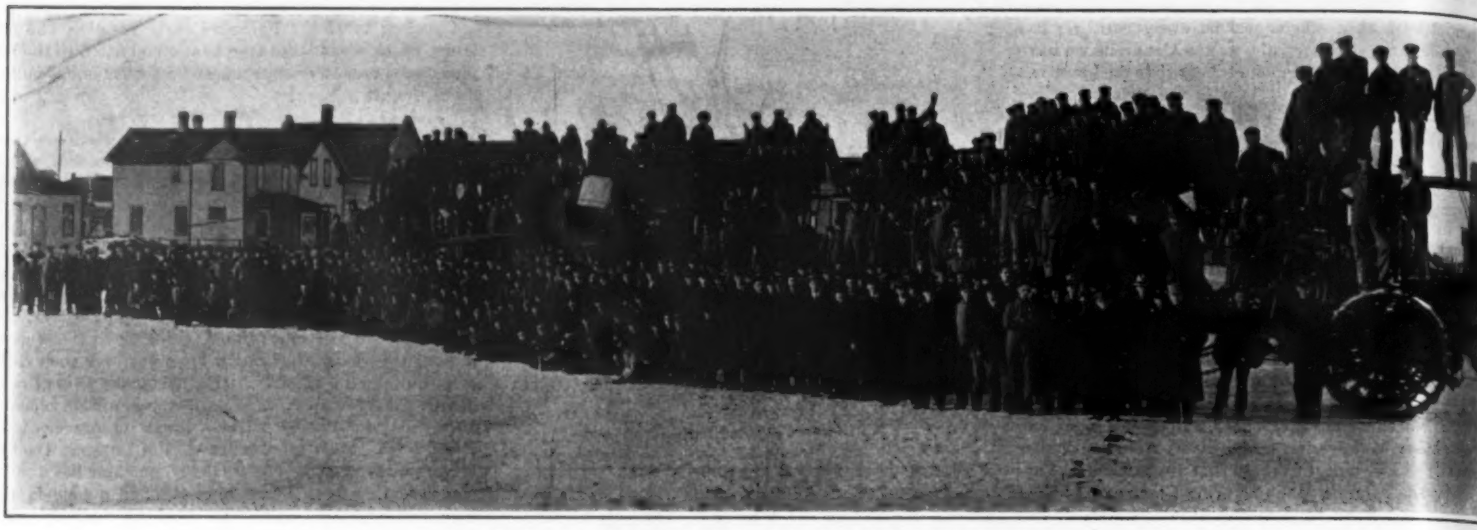
Messrs. Ponche and Primard do not, for some reason, believe in soudure autogene. They prefer to use aluminium sockets to assemble their steel construction work. One of the points in last year's machine was that, while the under surface of the wings was covered with aluminium sheeting, the top surface was left uncovered, allowing such necessary parts as spars to offer untold head resistance. They have changed this by covering the top of the wings with fabric. During the past few months they have had one of their monoplanes flying with a 50 horse-power Gnome motor—almost an identical machine. They obtained a speed of 105 kilometers an hour with it. The estimated speed of the two-seater model—it has not yet been tried—is 130 kilometers per hour. It weighs about 700 pounds.

(To be continued.)

Precaution in Making Litharge-Glycerine Cement

One of the most useful of the common cements is the well-known litharge-glycerine cement, which when properly made is waterproof and very strong. Precaution should be taken that the ingredients are free from water, however, to insure success. Before mixing a batch, mix up a small pellet and lay it aside to harden. If it does not harden in fifteen to twenty minutes, the probability is that the litharge is damp or the glycerine contains some free water, or both. The litharge should be carefully dried at a low temperature and the glycerine heated over a slow fire until the water is driven off. The litharge and glycerine should be thoroughly mixed, using as little glycerine as possible to thoroughly incorporate, and then add glycerine until the required plasticity is attained.

Public Telephone Booths in Berlin.—Berlin is at present well supplied with public telephone booths owing to the efforts of the administration, but in addition to what is now provided, the Chamber of Commerce is making a move to have telephone booths placed in the streets or public squares so that they will be conveniently within reach of the public. At present booths are to be found at railroad depots, postoffices and newspaper kiosks.



A Group of Students at the Tractioneering School, Regina, Saskatchewan.

Schools for Tractioneers

Well Qualified Men in Great Demand

We had occasion some time ago to bring to the notice of our readers the important work being done in the systematic training of "tractioneers," men thoroughly qualified to handle the somewhat complex mechanical equipment of the modern farm. With this issue we bring a supplementary note of the progress of the work, more particularly at the schools of La Porte, Indiana, and of Regina, Saskatchewan.

We quote from the *La Porte Herald*:

"Prof. C. I. Gunness, formerly of North Dakota Agricultural College and now head of the Indiana School of Tractioneering, is amazed at the response that is being made to the offer of special short courses in agricultural engineering. Even at that he sees no prospective of being able to turn out enough trained men to meet next season's demands. To quote his own words:

"'After a careful survey of the situation we find that we can place 500 tractioneers in paying jobs between now and April 1st. We have a call for more than 100 capable experts from one manufacturing concern alone. The wages offered vary from $65 to $200 per month, depending upon the ability of the men, and the locality and nature of the work.

"'To fill this demand for engineers we have made preparations to train a large number of men at our residence school in La Porte. We are in a position to actually train these men for responsible positions, and we are not satisfied by giving them a general conception of the gasoline engine. We have the facilities for teaching men the theory and principles of gas engine operation, and at the same time give them the practical work which will qualify them for operating and experting all types of gas engines.

"'We have made arrangements with the Rumely Products Company of La Porte to place our advanced students in their gas engine rebuilding and repair shop. Several types of stationary and traction engines will be overhauled and repaired. The opportunity of working in this shop will give the best possible experience for students in engine experting. Students will be paid for the work that they do in these shops, and they are thus given a chance to earn part of their expenses while attending the school. The amount that can be earned will depend upon the experience and the ability of the student who enters the school.

"'Some students may be unable to spend more than a small amount of time in the shop while attending their first term of school, while others may be qualified to enter the shops as soon as they enroll.

"'Men who simply wish to learn to operate engines should be able to do so by completing one term of seven weeks, while those who wish to qualify for experts should plan on spending two terms unless they have the previous experience or training.

"'We consider that we offer exceptional opportunities to men who wish to gain a thorough knowledge of the gas traction engine. The combination of a thorough technical training in the class room with practical repair and expert work under modern factory conditions cannot be excelled for training operators and experts.

"'The tuition for a term of seven weeks is $35 and the capable student will be able to earn part of this amount in the repair shop. Our term opens November 4th, 1912, and already we are in receipt of applications from many States—some even from as far away as North Dakota. Much interest is also being taken in our correspondence courses."

"'From the above it seems that what Dr. Rumely has frequently said regarding the scarcity of skilled labor is true of the farm and the farm machinery trade as it is in general manufacturing circles. Many LaPorte boys who have picked up their education by degrees are making good, though they doubtless wish they had had the advantages of such a short cut as the school offers.'"

Some of the buildings of the Indiana School of Tractioneering, La Porte, are shown in our accompanying illustrations.

The log building was built by the boys of Interlaken School, and has been converted into a tractor laboratory. Many types of accessories, such as carbureters, lubricators, magnetos, etc., have been assembled for class room purposes; also a number of stationary engines. Arrangements have been made with several of the large tractor manufacturers for the loan of tractors, plows, etc. The little building at the rear is the power house upon which the school depends for light and heat.

The brick building is used for office and class room purposes. One hundred and fifty resident students can be accommodated at one time. Arrangements have been made whereby any resident student who is qualified to handle tools intelligently, will be given work for several days a week in the repair shop of Rumely Products Company, Inc., where they will be able to earn their tuition, and possibly more, in the actual work of repairing and rebuilding tractors. Prof. Gunness has positive assurance that he can find jobs for at least 300, and very probably 500 graduates of the school before May 1st.

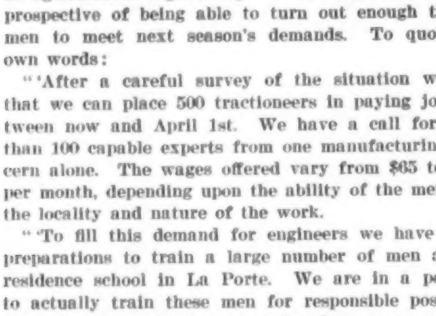
The correspondence course is rapidly rounding into shape, the first lesson having already been issued, and the others which are being written by a really noted body of men throughout the country, are nearly completed.

The resident instructors include Prof. C. I. Gunness of North Dakota Agricultural College, Prof. F. E. Wilson, of the Kansas State Agricultural College; Don E. Wormley, a graduate in agricultural engineering of Iowa State College, and Frank Johnson, who had charge of traveling schools in the northwest last winter.

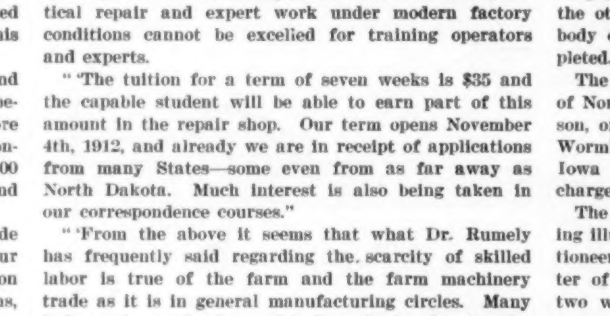
The two groups of students shown in our remaining illustrations are views taken at the School of Tractioneering at Regina, Saskatchewan, during the winter of 1911-1912. Nearly 500 men attended, spending two weeks of their time and considerable money in carfare, hotel bills, etc., to learn how to run tractors to better advantage.

Numerous types of tractors were used for laboratory purposes. A diploma was granted to each man who successfully finished the course and those who could not make good progress were kindly notified that there was no use in their continuing. A corps of fifteen experts assisted the expert in charge of the school. Practically every man who attended the school qualified as a tractioneer when the plowing season opened in the spring. Some carried on business on their own tractors, and some worked at handsome wages for owners of large farms. The spring takes practically every man out of the cities who can run a tractor.

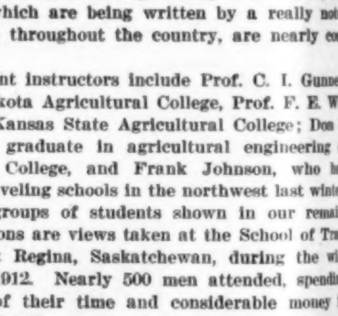
In these days of "overfilled professions," it is well to note this field which offers good opportunities for the right man.



The Administration Building.



In the Foreground, the Engineering Building. At the Back the Administration Building.



Prof. C. I. Gunness, General Manager.

THE SCHOOL OF TRACTIONEERING, LA PORTE, INDIANA.

The Physical and Chemical Processes in Autogenous Cutting*

By Prof. D. A. Stavenhaven

The real inventor of the process of autogenous cutting is the cracksman Brown, who in 1890 broke open a safe in Hanover by means of the oxyhydrogen blowpipe. The first experiments with autogenous cutting, I myself performed in 1895 in my lectures on inorganic chemistry at the technical university in Berlin.

Inasmuch as rather divergent views have been expressed in the literature and among technical men regarding the physical and chemical processes involved, I have subjected these processes to a somewhat careful study, the results of which I submit herewith.

The expression "Autogenous Cutting" is not very happily chosen, inasmuch as it is apt to give rise to erroneous impressions. There is, of course, no true "cutting," the operation is one of fusion and combustion. It is clear that a body can be burnt only if it is first raised to its ignition temperature. The substance which burns up in autogenous cutting is iron, which is heated to its ignition point by means of an oxy-hydrogen blowpipe flame. The melting point of pure iron is about 1505 degrees; no data are available as regards its ignition point. I have determined the ignition temperature of iron by the aid of a Kurlbaum pyrometer, and have found it to be 2200 deg. Cent. This result is unquestionably too high, for the disassociation of water begins at temperatures considerably below this and is quite far advanced at 2000 degrees, so that temperatures above 2000 degrees cannot be attained by means of the oxy-hydrogen blowpipe. But iron burns quite readily under the action of oxy-hydrogen blowpipe, so that its ignition temperature must lie below 2000 degrees.

The fusion and combustion of iron which must necessarily take place in the process of autogenous cutting can be secured by means of the oxy-hydrogen flame with an excess of oxygen under pressure only with varieties of iron whose melting point lies above about 1400 deg. Cent. A plate of soft cast iron, for instance, with a melting point of 1100, cannot be cut through in this way. This circumstance is explained by the fact that cast iron, though indeed it melts in the oxy-hydrogen flame, as can readily be shown experimentally, fails to ignite even in the presence of an excess of oxygen. The ignition temperature of iron cannot be reached because there is too large an interval (about 800 degrees) between this ignition temperature and the melting point of cast iron. So long as the whole mass of the cast iron is not melted the temperature remains unchanged, because any further heat supplied is used up in converting solid cast iron into the molten state. This consumption of the heat supplied by the blowpipe flame continues until the whole of the cast iron is converted into the liquid state. Another important factor is heat conduction, which must play a more important rôle at a lower than at a higher temperature. The ignition temperature of iron can for these reasons not be reached by the aid of the oxy-hydrogen blowpipe when working with a large piece of material. Combustion of the iron by the oxy-hydrogen blowpipe in the presence of an excess of oxygen under pressure can occur only with very small pieces of the cast iron. In this case, the amount of iron to be melted is small and thus the amount of latent heat absorbed is correspondingly small. Chemically speaking, the presence of a somewhat high percentage of carbon also militates against the combustion of the iron, because the ignition temperature of the carbon is lower than that of the iron. The substance of lower ignition temperature burns first, and thereupon the one with a higher ignition point. Only after the major part of the carbon present in the cast iron is burnt up, in other words after the cast iron has been converted into steel or soft iron, does any combustion of the iron take place.

Among the chemical reactions which determine the heat of the reaction must be mentioned: 1. The formation of water; 2. The formation of ferrous, ferric and ferroso-ferric oxide; 3. The formation of carbon dioxide. All these reactions are exothermic, and the heat liberated thereby is available for the operation of cutting or more properly melting and burning of the iron. Not the whole of this heat, however, is thus available, as a certain quantity is absorbed in the evaporation and disassociation of the water formed, and also in the fusion of the oxides of iron.

In addition to the reactions already mentioned, quite appreciable quantities of oxides of nitrogen are formed during the combustion of the iron in air. We have here a strongly endothermic process. Patents have been obtained (for instance, the German patent 192,883, Bender) for the production of oxides of nitrogen by the combustion of carbon or hydro-carbons in oxygen. Oxides of nitrogen are formed only if there are no reducing gases present, or in other words, when there is an excess of oxygen. In the same way oxides of nitrogen are formed when iron is burnt in an excess of oxygen. In the well-known experiment of burning a watch-spring in oxygen, I was unable to detect the formation of any oxides of nitrogen, but such oxides were found after the combustion of iron in the oxy-hydrogen blowpipe flame. It is also a well-known fact that this flame alone, burning in air, produces a small quantity of nitrogen oxides.

If, instead of pure hydrogen, acetylene, coal gas, or blaugas, etc., is used, the chemical reactions and their product are considerably altered. There is less water formed, and more carbon dioxide, while the amount of oxides of nitrogen produced does not seem to vary much.

An interesting process occurs if, instead of hydrogen, ammonia or carbon monoxide is burnt with an excess of oxygen under pressure. Thin iron plates can be cut by means of such an oxy-ammonia flame. Such a flame, of course, produces greater quantities of oxides of nitrogen. Thick plates cannot be cut with ammonia unless hydrogen be mixed with it. The amount of nitrogen oxides formed by the oxy-ammonia flame is considerably increased by the presence of burning iron, and owing to the rapid removal of the products of combustion by the stream of compressed oxygen, these products are not greatly exposed to re-decomposition. If carbon monoxide is used instead of hydrogen, iron can be burnt in an oxygen-carbon monoxide flame. In this case, no nitrogen oxides could be detected, a fact which was more or less obviously to be expected, inasmuch as atmospheric nitrogen cannot combine with oxygen in the presence of a strongly reducing gas such as carbon monoxide. Incidentally it should be mentioned that when such an oxygen-carbon monoxide flame is used, small quantities of cyanogen compounds may be formed.

*Paper read at the Eighth International Congress of Applied Chemistry.

Microradiography

A New Application of X-rays

Few discoveries of science within the last twenty-five years or so have attracted more attention than the announcement in 1895 by Röntgen of his observations on X-rays. And the very next year this discovery passed from the ranks of mere scientific curiosities into the field of practical application. For in 1896 the physician, Leopold Freund, made use of the new rays, both for diagnostic and therapeutic purposes. This is now seventeen years ago, but it must not be supposed that the story of the X-rays and their application is completed. On the contrary, there are indications that the future will bring further developments of the highest importance. Just at the present time considerable interest is being aroused by the recent work in microradiography—the photography of microscopic structures by means of X-rays. A communication on this subject was made before the recent meeting of the French Association for the Advancement of Science, by M. P. Goby. This investigator, says *La Nature*, has succeeded in producing very sharp images of various microscopic objects, such as calcareous protozoa or portions of small shell-molluscs or even vertebrates.

The new method of observation is particularly useful in studying certain palaeontological specimens, such as foraminifera and diatoms, which figure so prominently in some geological formations, and whose internal structure is thus laid bare. Thus a pinch of foraminiferous sand (Figs. 1 to 4) may disclose a number of new species. A single radiograph may show in detail many features which otherwise could have been discovered only by a tedious process of preparing section after section of the specimen under examination. Thus, for example, M. Goby has demonstrated the existence of two distinct species of foramonifers which the ordinary methods had failed to recognize. Radiomicrography is also a most useful adjunct in the study of shells, which appear as transparent bodies, showing clearly the central columella around which the spiral of the shell is wound. Our illustrations, Figs. 5 and 6 for example, show a specimen of *Pupa similis* in two stages of development. Another application in which microradiography seems destined to render signal services is the study of the various stages of development of living individuals from the time of their birth to the adult stage.

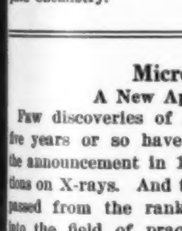
An investigation by somewhat similar means, but in an entirely different branch of science, is the study of the pattern produced by X-rays passing through crystalline bodies. A communication of this subject appears in a recent issue of *Nature*. Mr. W. H. Bragg writes:

"Messrs. Friedrich, Knipping and Laue have recently published (*K. Bayer. Akad. der Wiss.*, 1912, p. 303) some remarkable effects obtained by passing a fine stream of X-rays through a crystal before incidence upon a photographic plate. A curious arrangement of spots is found upon the plate, some of them so far removed from the central spot that they must be ascribed to rays which make large angles with the original pencil.

"The positions of these spots seem to depend on simple numerical relations, and on the mode in which the crystal presents itself to the incident stream. I find that when the crystal (zincblende) is placed so that the incident rays are parallel to an edge of the cube in the crystal the position of the spots are to be found by the following simple rule. The atoms being assumed to be arranged in rectangular fashion, any direction which joins an atom to a neighbor at a distance na from it, where a is the distance from the atom to the nearest neighbors and n is a whole number, is a direction which a deflected (or secondary) pencil will take, and it will in doing so form one of the spots. In other words, we have to seek for all the cases in which the sum of three squares is also a square, and we then recover the positions of all the spots on the diagram. For example, secondary pencils take the directions (2, 3, 6) (4, 1, 8), and so on. In a few cases the sum of the squares is one short of a perfect square, e. g. (5, 7, 11), but in no case is it on the greater side; and there is at least one direction (2, 5, 14) which ought by the rule to be on the diagram and is not. Otherwise the rule is quite successful.

"Until further experimental results are available, it is difficult to distinguish between various explanations which suggest themselves. It is clear, however, that the diagram is an illustration of the arrangement of the atoms in the crystal.

"The rule has suggested itself to me as a consequence of an attempt to combine Dr. Laue's theory with a fact which my son pointed out to me, viz., that all the directions of the secondary pencils in this position of the crystal are 'avenues' between the crystal atoms."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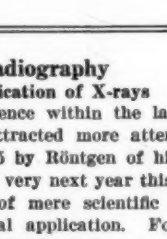
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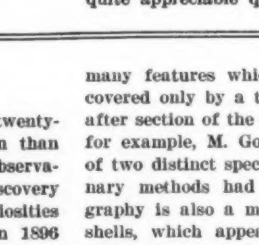
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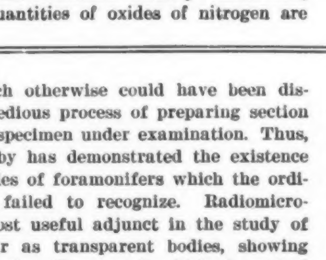
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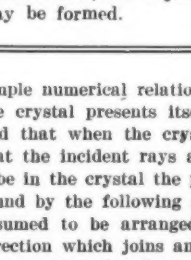
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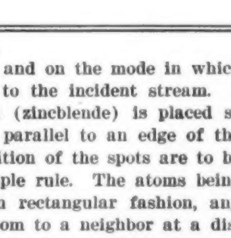
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Fig. 1.—Nummulites. Fig. 2.—Rotalina Orbicularis. Fig 3.—Diatomaceæ. Fig. 4.—Various Foraminifers. Figs. 5 and 6.—Pupa Similis at Different Stages.

Sugar Beet Seed Growing in the United States*

Good Crops Can Be Raised On American Soil

By C. O. Townsend

THE production of sugar beet seed in the United States involves the same general principles that are embraced in the production of sugar beet seed in other countries. In considering this question, therefore, it will be best to go over the principles which have to do with the growing of beet seed in general and to note the special factors which influence beet seed growing in the United States, in so far as they differ from the factors governing this industry elsewhere. In this connection it should be said that the growing of beet seed in this country is still in an experimental stage, and probably will not develop for many years into a commercial proposition which shall be capable of supplying the home demand, at least not until the soil and climatic conditions in the various localities have been thoroughly tested and found suitable for the establishment of this new industry on a safe basis. Even then it will be wise to develop the industry gradually, for the reasons that will be apparent as we study its requirements. For many years a more or less general idea has prevailed, both in this country and abroad, that high grade sugar beet seed could not be grown in the United States. However, work along this line is under way in several of our sugar beet centers where it will be thoroughly tested for the reason that there exists in the minds of many of the beet sugar producers of this country a feeling that the beet sugar industry will never be on a secure footing with all the possibilities of development of which it is capable until we are no longer dependent upon foreign countries for our seed supply. This feeling exists without any prejudice against the foreign grown seed or against the man who grows it, but simply for the reason that so long as we must rely upon the importation of beet seed for the production of our crop, the beet sugar industry in this country will be dependent upon the success or failure of the seed crop in other countries and upon the various changes in our trade relations that may arise from time to time with the present seed producing countries. The adverse conditions which prevailed last year in nearly all the beet seed producing countries of the old world resulted in a shortage of the seed crop which increased the selling price several fold, and made it almost impossible for this country to get a supply of good seed adequate for its needs. Another partial failure of the seed crop in the near future would so deplete the world's supply of beet seed that the beet sugar industry would be badly crippled, if not entirely destroyed, in certain sections for the time being at least.

Another reason for the production of home grown beet seed still more potent than any of those mentioned is to be found in the laws of plant growth and development. If we plant the seed from a single beet root grown from any of the so-called varieties now in use, we shall obtain a large number of types on strains as indicated by the habit of growth and texture of both leaf and root and in their ability to manufacture and store sugar. In order to make the greatest progress in sugar beet sugar production we should select the type or types best adapted to a given locality until we get a pure type of the strain or strains selected. This will require careful selection through several generations, but until we get these pure strains possessing the desired characters upon which to base our future breeding and selection we cannot hope to get the highest results from the standpoint of tonnage and quality of the roots. Having secured the pure strains desired, we are then in a position to re-combine the strains that possess the characters most desirable or to continue the pure strains as such if they possess the characters that are most desired. Following the laws of plant growth as influenced by environment we shall find that certain types or strains produce the best results in a given locality, while other types or strains are better suited to other localities. For this reason it is advisable not only that the seed to be used in producing a given crop be grown in the country where the crop is to be produced, but also that the various sections of that country, especially if the climatic conditions are widely different, should have each its own strain of seed. It is apparent, therefore, that sugar beet growing will not reach its highest plane of development in this country until we are able to produce our own seed in accordance with the principles of selection, breeding, and adaptation to environment.

In looking over the varied conditions of soil and climate which prevail in the several sugar beet sections of this country, one cannot help being impressed with the fact that we have in many places soil and climatic conditions which seem to be the best for the growing of sugar beet seed. In accordance with the foregoing considerations it stands to reason that beet seed growing in the United States, and especially in the sugar beet centers, will be best adapted to our needs, from the standpoint both of tonnage and quality. This is the natural law with reference to other crops, and there is no reason to believe that the same law does not hold in regard to sugar beets. It is entirely possible that beet seed of satisfactory quality and yield might be grown in this country entirely outside of our present sugar beet centers. It seems desirable, however, to confine our efforts, for the present, to those localities where sugar beets are now grown commercially, for the reason that such localities present better facilities for the selection of suitable roots, and furthermore, all discarded roots can then be put through the factory, thereby avoiding serious loss.

In considering the advisability of entering into the growing of sugar beet seed commercially, a number of factors upon which the success or failure of the enterprise depend should be carefully noted. These are in the main climate and soil and the personality of the individual upon whom the details of the work must rest. This latter factor, in the judgment of the writer, is the one of greatest importance, because the individual who grows the seed, or who is intrusted with the details of the work, must be a close observer, one who is capable of taking infinite pains in all the details, and one who is absolutely honest with himself and with the public. In regard to the soil it may be said that a dark, rich, loamy soil is the best for the production of beet seed. Such soils are found in practically all of the sugar beet localities in this country. The climatic conditions are more complex and should be carefully considered before undertaking such an important work on a large scale. The elements of climate have a direct bearing upon seed production are temperature, precipitation, and wind. Both winter and summer temperatures are to be considered for the reason that beet seeds require two growing seasons for production. The roots grown one season must be kept over winter and planted out the next season. It is important that the roots remain dormant during the winter. To this end the roots should be kept just as close as possible to the freezing point without being frosted. It is possible for the temperature to fall several degrees below freezing point without injuring the beets. The summer temperature is equally important since a too high temperature at the time the seed is setting will cause more or less of it to blast, so that the crop will be a failure or a partial failure. Rain at harvest time tends to give the seed a dark color which impairs its selling quality as the trade demands a bright seed. If the rains at harvest time are frequent, or even if the atmosphere is continuously damp, the seed not only turns dark but it tends to mold, a condition which may injure its germinating quality. The roots should have plenty of moisture while the seed is forming in order to produce good plump seed. High winds after the seed stalks have formed, and especially after the seed has set, may break down the seed stalks or break off the branches, thereby reducing the yield of seed. This difficulty may be overcome by the use of windbreaks. Any one of these climatic elements may be the limiting factor to exclude the possibility of profitable beet seed production in a given locality. It should be noted that there are other limiting factors such as diseases, insect pests, and other agencies which may so affect the buds that seed stalks fail to form, or they may prevent the formation or development of the seed. These factors are not confined to any locality nor to any country, but the ability to control them must be reckoned with in considering the establishment of so important an industry.

If one has convinced himself that the chances for success in beet seed growing are reasonably sure it will still be wise to start the work on a small scale. This will enable one to study the soil, climatic conditions, and other limiting factors in relation to seed production, and at the same time give him an opportunity to look closely after all the details and to adapt himself to his new line of work so that he can safely increase his business from year to year with a minimum chance of failure. Having decided to undertake the production of sugar beet seed, the first step consists in selecting suitable roots as seed beets. In the selection of roots attention must be given to size, shape, and quality. Size may or may not be an important factor, depending upon the conditions under which the beets were grown. If the roots are grown close together in poor soil, or with an abnormally small amount of moisture, the size is not of any considerable importance. On the other hand, if the roots are small under favorable conditions of growth, that is if they are inherently small, they should be avoided since selection along this line would tend to produce a strain of beets of low tonnage. Attention should also be given to the relative size of the top. Tops that are abnormally large at the expense of the root growth are not desirable for seed production. The shape of both root and crown are important factors in the selection of seed beets. The roots should be of good length and should not taper too suddenly. On the other hand, they should carry their size well down toward the middle part of the root and should then taper gradually to a well formed single point. The root should be so twisted that the sutures, and consequently the feeding roots, present a spiral appearance. This gives the beet a chance to draw its food supply from all directions around the root. The crown should not be elongated, but should be nearly flat, and practically flush with the surface of the ground. This will tend to keep the crown-tare down to a minimum. The crown should not be abnormally broad in proportion to the size of the root, but should be well supplied with buds for the production of seed-stalks.

Having selected the roots with reference to size and shape, the next and most important consideration is that of quality, which embraces both sugar and purity. In general the purity of the individual root is neglected for the reason that no satisfactory method has been devised for the determination of the purity of a single root without rendering it unfit for seed production. By purity is meant the proportion of sugar to the total solids in the juice and purity is closely related to the maturity of the beet. The importance of producing beets with a high co-efficient of purity lies in the fact that one part of the salts taken up from the soil by the beet root will keep four parts of sugar from crystallizing and forming commercial sugar. In actual work the purity is checked up from time to time by an analysis of several of the seed roots as a composite sample, thereby getting juice enough to make a purity test. The sugar content of the roots can and should be determined for each root to be used for seed production. This is done by taking a core out of each beet starting at the shoulder and extending diagonally through the root and subjecting it to a polariscope test. Each beet seed growing farm should, therefore, have a testing laboratory equipped with suitable apparatus for making sugar and purity determinations. It is customary for beet seed growers to fix upon some satisfactory sugar content and to discard all roots showing a lower sugar content than the one fixed upon. While the sugar content of roots does not seem to be a fixed characteristic of the beet in the sense that color, shape, and habits of growth are fixed characteristics, yet the tendency in the beet roots to store sugar is of the highest importance and should receive the most careful attention. To this end the individual who undertakes the production of beet seed should be thoroughly conscientious and reliable, so that he will without any hesitation discard those roots that are not strictly up to the standard. It would be absolutely useless to undertake the growing of beet seed unless the proper equipment can be provided and utilized in such manner that the quality of the roots shall constantly improve or at least shall not deteriorate.

Having selected the roots with reference to the above named factors, the next step consists in storing the roots so that they will keep in a perfectly sound condition until the following spring without starting a new leaf growth. In putting the beets away in the fall the leaves should be removed without injuring the buds. In some instances the roots are stored in root cellars, but it is a common practice, and one that has been found very satisfactory, to silo the beets in the open. To do this the beets are piled on a well drained spot in the field and then covered with earth or preferably with sand. All spaces between the roots should be filled with the sand to retard evaporation, and to prevent field mice from wintering in the beet piles, where they would do considerable damage to the roots and especially to the dormant buds. In any case the roots should be put into the storage

* Paper read before the Eighth International Congress of Applied Chemistry.

cellar or silo in a perfectly fresh and crisp condition. If they are allowed to wilt they do not keep well in the silo, and as a rule do not thrive when planted out for seed. As indicated above, the silo should be covered with just enough dirt to keep the roots from freezing without causing them to heat. This covering will differ in the various beet seed growing localities and indeed in the same locality from year to year. It is, therefore, a wise plan to cover the silo lightly at first and to increase the covering from time to time as the weather becomes more severe.

The roots should be planted out in the spring as early as the soil and weather conditions will permit. This will be several weeks earlier, usually, than the seed itself can be planted with safety. The ground should be plowed deep and firmed down to a good bed. It should be marked out in checks so that the roots, when planted, will stand in rows each way in order that the beets may be cultivated both ways. The beets should be from two and one half to three feet apart each way so that the tops will have plenty of room and so that the cultivator can be run between the rows without breaking down the seed stalks. In planting the roots it is best to take them from the silo and drop them at the points where they are to be planted, then take a long spade and force it perpendicularly into the ground to a depth as great as the length of the root, pushing the spade forward and crowding the beet root into the open space just back of the spade. The root should be held in place and the spade withdrawn. The dirt should be firmly packed around the root, the top of which should be just flush with the top of the ground. The soil at the time the roots are planted should be moist, but not wet. The field should be kept free from weed and should receive frequent cultivations to conserve the moisture. Especial pains should be taken to see that the beets are well supplied with moisture at the time the seed is forming, otherwise the yield and quality of the seed will be greatly reduced. After the seed has formed, the water, if under control, should be withheld in order to allow the seed to ripen. No special attention need be given to the pollination of the flowers as that takes place naturally by the action of the wind and insects. The flowers produce a great abundance of pollen, so that the atmosphere in a beet seed field, at pollination time, is filled with the yellow powder. As the seed begins to ripen it assumes a yellowish tinge, which eventually changes to a light brown color when it is ripe. The seeds near the attached ends of the stems and branches are the first to ripen while the distal or free ends of the branches frequently have immature florets at harvest time. The seed should be harvested just before it begins to shatter. Harvesting is accomplished by cutting off the seed stalks close to the ground and piling them in small piles until they are thoroughly dry. They are then pitched onto a rack and hauled to a suitable place for threshing. If the seed shatters when hauled it is best to spread a canvas in the bottom of the rack; otherwise some of the seed of the best quality will be lost. In the older beet seed countries the seed is threshed by means of a special machine, but in this country it is put through an ordinary threshing machine, or is tramped or pounded out on a level floor. It is then cleaned by putting it through a fanning mill which takes out the lighter material. After this it is made to fall upon a canvas belt six or eight feet in length and several feet wide, which is inclined at the proper angle and is constantly rotated toward the high end so that the seed as it falls upon it is carried by its own weight down into the receiver, while the broken stems and branches are carried over by the canvas and discarded. The seed is then spread in some suitable place to dry. Some seed firms have artificial dryers, but the seed can be spread upon a clean floor and stirred from time to time until it is thoroughly dry, when it can be sacked without danger of molding. The standard generally adopted for marketable sugar beet seed specifies that the moisture content shall not exceed fifteen per cent, and that the impurities shall not exceed three per cent.

There are only a few pests that are troublesome to seed beets. The disease especially to be dreaded is the "curly top." It is never advisable to make any selections for seed beets in fields where there is any appreciable number of curly top beets, since it has been observed that beets may be affected with curly top without showing symptoms of the disease until the roots have begun their second year growth. Such roots produce little if any seed and in fact often fail to throw up seed stalks at all. Likewise roots that are in the least affected with root rot or crown rot should be discarded and not placed in the silo. Even if they go through the winter without any apparent development of the rot, they will usually decay the second year, and the labor of selecting, testing, siloing, and planting them is lost.

Leaf spot is as a rule not a serious menace to beet seed growing. It should be prevented, however, by growing the seed in a field not infected with the fungus since the spores may become attached to the rough coats of the seed, and in this way be spread to localities not hitherto infested with it. In some parts of the West the Jack Rabbit is the worst enemy of the seed beet. Since the beet roots are planted out early in the spring they furnish a favorite feeding ground for this animal. It would, therefore, be useless to try to grow beet seed in certain localities until the Jack Rabbit is exterminated, or until some inexpensive method is found whereby his ravages may be prevented.

When beet seed of good quality has been produced in comercial quantities, it is important that its reputation as a seed, up to the standard in germination and capable of producing roots of good tonnage and quality should be established. This reputation must be founded upon actual facts and should be capable of demonstration to practical growers. To this end it should be thoroughly tested in comparison with standard sugar beet seeds. These tests should be made by growers of unquestionable reputation who will give the seed a fair test. When the reputation of the seed has become established so that there is a demand for it every effort should be made to maintain and, if possible, to improve that reputation with each succeeding crop. Enough has already been done to prove that the limiting factors may be overcome, and that beet seed of good quality can be grown in this country at least in limited areas. It remains to be shown to what extent these areas can be increased, and with what success new areas may be developed in this important industry.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Gyroscopic Force in Aeroplanes

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

I have read with interest Mr. Ralph M. Pearson's letter in the SCIENTIFIC AMERICAN of October 26th in answer to my letter published in the SCIENTIFIC AMERICAN of August 10th regarding the accident resulting in the death of Miss Quimby and Mr. Willard, and the action of gyroscopic force in this accident.

Mr. Pearson has made several misstatements which I should like to correct, and I should also like to say a few more words on this very important subject.

Mr. Pearson entirely ignores the fact that the control wire, in the case of the Quimby accident, was naturally caught when we examined the machine as it lay upside down stuck in the mud. I have a photograph of myself standing on the wrecked monoplane, pointing to the caught control wire. He states that I obtained affidavits to prove that the machine swerved to the left. I did not do so. The discussion was as to whether or not the controls were caught. I claimed that they were caught, and Miss Quimby's mechanic, for some reason known to himself only, claimed that they were not caught. I produced affidavits from two reliable witnesses to prove that the control wire was caught. With regard to the machine swerving to the left, I simply state that it was interesting to note in this connection that both Capt. Chase and myself agreed that the machine did swerve to the left before we knew that the controls were crossed, and we afterward found that the crossing of these controls would make it swerve as indicated. The very fact that it happened that gyroscopic force would also make it swerve to the left in the case of a very rapid change in the plane of rotation, has nothing to do with the proposition. This could easily be a coincidence, and I believe firmly that it was. There is one indisputable fact, and that is that the controls were crossed in such a manner that if they had been crossed in the air as they were in the water when we found the wreck, no aviator in the world could have brought the machine down safely. Of course, I cannot prove that the controls were caught in the air, but they were certainly caught in the water when we examined the wreck, and circumstantial evidence goes to prove that they were caught in the air.

Mr. Pearson cites a simple experiment with a gyroscopic top. He says: "Turn it *sharply* to the left, and note that the forward end of the axis dives downward, and the quicker you turn, the more powerful the swerve." Of course, this is a fact with which every one who knows anything about gyroscopes is familiar. But Mr. Pearson evidently did not read many of the opinions which came out at the time of this accident in the Boston papers. Almost every one agreed that at the time Miss Quimby met her death she was flying in a horizontal plane, and there seemed to be no difficulty on account of air currents. Hundreds of witnesses agree that she was not having any difficulty in the control of her machine. What, then, would make her machine swerve to the left sharply if it were not a crossed control? A woman who had flown the English Channel was not going to lose control of an aeroplane flying under such ideal conditions.

Mr. Pearson cites the experiment of the Seguin brothers. He states that in a half-second turn there is the equivalent of a 1,382-pound blow struck the machine. All I can say is that nobody ever turns an aeroplane around in half a second, and no one ever will. The mass of an aeroplane is so great, and the damping effect of the wings is also so great, that a turn in any such time as half a second is out of the question, even if any aviator were fool enough to try it.

Mr. Pearson states: "In the first place, a number of eye witnesses, himself [meaning myself] included, state positively that after Willard had been thrown out, Miss Quimby succeeded in righting the machine." I never made any such statement. I was looking straight at the aeroplane when the accident happened. Mr. Willard was thrown out first, and a fraction of a second later he was followed by Miss Quimby. There was no indication that Miss Quimby even partially regained control of her machine.

Later Mr. Pearson asks, "Then, again, with the rudder jammed to the left, how could the machine have sailed straight down and avoided a series of spirals?" The machine did not go straight down, as hundreds of witnesses will testify. The machine did not land upright in a normal position. It did make a spiral, and struck the water upside down, turning completely over in the air, and landing upside down. When we got out to it, the machine was stuck tightly in the mud and the water was about four or five feet deep. If the machine had landed in a normal position and then turned over, it would not have been stuck so tightly in the mud. In fact, it probably would not have stuck in the mud at all. As it was, it struck upside down and buried itself in the mud.

I will agree that it would be a mighty good thing if some authoritative body undertook to investigate this gyroscopic force as applied to aeroplane motors, if for no other reason than to set at rest a discussion which I believe is doing much harm to aviation. It is all very well for Mr. Pearson and Mr. Brooke to blame every accident on gyroscopic force, but they cannot prove their claims. I ask, as I have before, *that they obtain the affidavit of one single reliable aviator who has had extensive experience with a rotary motor*, and who has ever had any difficulty on account of gyroscopic force. *If gyroscopic force kills so many men, it certainly would inconvenience the aviators who have done trick flying and who have made comparatively quick turns in aeroplanes driven by rotary motors.* I have flown hundreds of miles in my Blériot driven by a 70 horse-power Gnome motor, and I *know* that gyroscopic force never gave me the slightest trouble. I have talked with several aviators who have had extensive experience with rotary motors, and *they have never had any trouble.* Furthermore, considered from a theoretical standpoint, I claim that an aeroplane does not turn rapidly enough in practice to generate gyroscopic force of such a magnitude as to even slightly inconvenience an aviator.

Mr. Pearson talks about the Quimby accident, and bases his opinion upon what he has read. I had charge of the Boston meet at the time Miss Quimby was killed. I was looking straight at her machine at the time of the accident. I was the first one to examine the wrecked monoplane. I have flown hundreds of miles in almost the same machine that she used. I understand very well the action of the gyroscope. I am not selling or in any way identified with the manufacture of a non-gyroscopic motor. It seems to me, therefore, fair to assume that particularly in a case like this Quimby accident, with which I am so familiar, that my opinion is of more value than that of a person who was not there at the time, who has, as far as I know, never flown an aeroplane with or without a gyroscopic motor, and who acknowledges at least an acquaintance with one who makes a motor wherein an effort is made to eliminate gyroscopic force.

Again let me emphasize one point. Let Mr. Pearson, or Mr. Brooke, or anybody else, obtain the testimony of an aviator who has had a wide experience with gyroscopic motors, and then they will have some foundation upon which to build their theories. The Gnome motor is the most widely used to-day, and hence there are hundreds of aviators who have had experience with them. *Find a single one who has ever experienced any difficulty on account of gyroscopic force.* EARLE L. OVINGTON.

Newton Highlands, Mass.

A Metallic Vapor Lamp Giving White Light.—The ordinary mercury vapor lamp, as invented by Mr. Cooper Hewitt, emits a light very poor in red rays, with the result that the face and hands of persons acquire a ghastly and cadaverous complexion when viewed in this light. It is reported that Drs. Wolfke and Ritzmann have overcome this defect by using, in place of plain mercury, a cadmium amalgam.

NEW BOOKS, ETC.

Grundlinien der Anorganischen Chemie. (Principles of Inorganic Chemistry.) By Prof. Wilhelm Ostwald. Third edition. Dresden and Leipzig: Theodor Steinkopff, 1912. 8vo.; 860 pp.; illustrated. Price, bound in cloth, marks 18.

Neither author nor book requires introduction. Among the numerous text-books of inorganic chemistry, Ostwald's stands out prominently by the refreshing originality of view which permeates all his writings. While the facts of chemistry presented can not vary greatly in the different smaller manuals published, there is so much individuality in Ostwald's book that no chemist's library is complete without it—no other work can quite take its place. The new edition has been brought thoroughly up-to-date, a special chapter being devoted to the radioactive elements.

A change which has been introduced in the early portion of the book is best explained in the author's own words. In the preface he says: "To me, as an experienced teacher of chemistry, it came as a surprise when I discovered some years ago, that the usual description of the preparation and properties of the various elements and compounds must be prefaced by a treatment of the properties and preparation of the three states of aggregation." Chapters IV and V are accordingly devoted to "Change of State" and "Solutions" respectively—which are dealt with in the author's masterly manner.

Outlines of General Chemistry. By Prof. Wilhelm Ostwald. Translated by W. W. Taylor. Third edition. London and New York: Macmillan & Co., 1912. 8vo.; 596 pp.; illustrated. Price, $5.50.

In the preface to an earlier edition of this work the author likens the book to "meat extract"—a food material which has its very excellent use, but which is not intended as the sole constituent of a steady diet. While this does not apply to the same extent to the later editions, which have grown considerably beyond the bounds of the first, it still remains true that these outlines represent a concise presentation of the main facts and principles of physical chemistry, a bird's eye view of the field covered in detail by the same author in his classic Lehrbuch.

In so far as the new edition follows the earlier issues, it is unnecessary to render detailed account.

An important addition is Book V, devoted to micro-chemistry, and dealing in particular with the phenomena presented by matter in a very fine state of division—disperse systems; a subject which has in late years risen to the highest importance by furnishing the experimental substantiation of the molecular conception of matter. The subject is treated with the author's characteristic lucidity and originality. Chapter XXVI, dealing with Conduction of Electricity in Gases and with Radioactivity, is of similar importance; for this is the field in which J. J. Thomson's great researches promise to unveil for us the mysteries of atomic structure and of the nature of chemical action.

It will be remembered that in past years Ostwald was an opponent of the kinetic theory. In the present work he unequivocally proclaims a change of front:

"I am now convinced that we have recently become possessed of experimental evidence of the discrete or grained nature of matter, which the atomic hypothesis sought in vain for hundreds and thousands of years. The isolation and counting of gas ions, on the one hand, . . . and, on the other, the agreement of the Brownian movements with requirements of the kinetic hypothesis, . . . justify the most cautious scientist in now speaking of the experimental proof of the atomic nature of matter. The atomic hypothesis is thus raised to the position of a scientifically well-founded theory. . . ."

In the face of recent developments, indeed, it seems hardly possible for any well-informed person to doubt the justification of the kinetic theory.

The Theory and Practice of Enamelling on Iron and Steel. With Historical Notes on the Use of Enamel. By Julius Grünwald. Translated by Herbert H. Hodgson, M.A., B.Sc., Ph.D. Philadelphia: J. B. Lippincott Company. 8vo.; 131 pp. Price, $2 net.

German skill in enamelling is too well known to need substantiating by argument. The annual output of the industry in Germany alone is not less than $15,000,000 and the result of work by trained investigators has been to vastly simplify production, and greatly to increase the use of enamelled ware by the general public. With a thoroughness characteristic of his type, Grünwald discusses the raw materials; the mixing, dissolving, and application of enamel; heating and pickling goods in the rough; correct laying on; baking; decoration; photo-ceramics in their application to enamels; and the history of enamels and their uses.

Gas and Oil Engines. A Concise Account of the Most Important Types. By Alfred Kirschke. Translated from the German and adapted to English practice by Charles Salter. New York: D. Van Nostrand Company, 1912. 16-mo.; 160 pp.; 55 illustrations. Price, $1.25 net.

This is volume II of the Broadway Series of Engineering Handbooks, and contains, in compact form, a great deal of general information about internal combustion engines, their history, progress, and prevailing types. The four-cycle and two-cycle systems are contrasted and explained, and this is followed by a chapter on the general construction and erection of gas engines. Engines for liquid fuel, gas producer plants, and the gas turbine, are each made the subject of a short paper, and some twenty pages of numerical tables complete the volume.

Diesel Engines for Land and Marine Work. By A. P. Chalkley, B.Sc. With an Introductory Chapter by Dr. Rudolf Diesel. New York: D. Van Nostrand Company, 1912. 8vo.; 226 pp.; illustrated. Price, $3 net.

Dr. Diesel's claim, as stated in his introduction, is that his motor is not only as reliable and satisfactory in operation as the best of other types, but that it excels them in simplicity, owing to the absence of all auxiliary plant and also because the fuel is employed directly in the cylinders without any previous transformatory process. The thermal efficiency is at present about 48 per cent, and cases have been noted in which the effective efficiency is nearly 35 per cent. Aside from the general uses to which the engine is put on land, there are 300 vessels propelled by it, hence, little apology is necessary for incorporating into one volume the hitherto scattered and fragmentary literature of the engine. Its action and working, its construction, installation, and test, its use in marine work and the special construction of the marine form, occupy the body of the work. The illustrations are plentiful and good, many of them being in the form of folding inserts. All grades of readers have been kept in view, quite elementary explanations having been included for the benefit of those lacking technical education.

Problems in Physical Chemistry. With Practical Applications. By Edmund B. R. Prideaux, M.A., D.Sc. New York: D. Van Nostrand Company, 1912. 8vo.; 311 pp. Price, $2 net.

The entire field of physical chemistry is covered by the problems of this book, which thus gives us a new, distinctly up-to-date "Chemical Arithmetic" which may do good work in familiarizing students with the methods of handling problems in physico-chemical investigation and technical chemistry. The arrangement is by sections, each introduced by a few words of explanation, and, subject to certain limitations of the nature of the discussion, these sections and the problems presented by them are progressive in character. Previous knowledge of fundamental laws is assumed throughout.

Boiler Draught. By H. Keay Pratt. New York: D. Van Nostrand Company, 1911. 12mo.; 138 pp.; illustrated. Price, $1.25 net.

"Boiler Draught" is issued with the object of aiding engineers to determine whether existing conditions in their plants are favorable to the economical consumption of fuel, or whether some better arrangement may not be possible. No claim of originality is made, but care has been taken to make all statements and explanations as clear as possible, so as to be of the greatest possible help to the engineer. In this a great measure of success has been obtained.

The Spatula Ink Formulary. Recipes and Directions for Making all Kinds of Inks for all Kinds of Purposes. By Dr. J. H. Oyster. Boston: The Spatula Publishing Company, 1912. 171 pp.

For thirty-five years Dr. Oyster has been collecting the thousand formulas that go to make up this compilation. His claim that practically all known recipes are here given seems to be borne out by a study of the pages. An index, while presenting some difficulties, would have added greatly to the convenience and usefulness of the volume.

Elementary Applied Chemistry. By Lewis B. Allyn. New York: Ginn & Co., 1912. 12mo.; 127 pp.; illustrated.

The author offers a text-book that seeks to create among students what he calls the "three I's of chemistry," interest, industry, and individuality. The exercises and applications are for the most part of a practical nature, and include sections on sanitary analysis of water, examination of baking powder, analysis of milk, examination of ice cream, cheese, and condensed milk, and distillation experiments. Some valuable tables are also given.

Transactions of the American Institute of Chemical Engineers. Vol. IV. 1911. New York: D. Van Nostrand Company, 1912. 8vo.; 514 pp.; illustrated. Price, $6 net.

In a most substantial and worthy volume, the American Institute of Chemical Engineers present their reports as read before the Third Semi-annual meeting, and publish some valuable papers on subjects varying from the manufacture of chloroform to the adaptation of the centrifugal pump to chemical problems. There is also a symposium on the United States patent system, pointing out its defects, suggesting remedies, and thoroughly reviewing the existing system in its relation to that field of activity for which the institute stands. In June, 1911, the institute created a Committee on Patents, which has conscientiously carried on an investigation of conditions, consulting with other organizations on matters of importance. This section of the work contains material of vital interest to all inventors and manufacturers of patented articles, and may be profitably read by many who can claim no affiliation with chemistry or with chemical engineering.

Tunneling. A Practical Treatise. By Charles Prelini, C.E. New York: D. Van Nostrand Company, 1912. 8vo.; 349 pp.; 167 illustrations. Price, $3 net.

The work is a sixth edition, revised and enlarged, and the progress made in the art of tunneling since the issue of the first edition is embodied and adequately presented in this issue. The arrangement of the work has been changed in order to give new methods due prominence. More space has also been devoted to the American method of excavating through rock and loose soil, and illustration has not been spared in the effort to make the text perfectly clear. With the exceptions mentioned, the general contents of the work are substantially the same as in previous editions, dealing with historical development, preliminary considerations, methods, machinery, and practice.

Railroad Finance. By Frederick A. Cleveland, Ph.D., LL.D., and Fred Wilbur Powell, A.M. New York: D. Appleton & Co., 1912. 8vo.; 463 pp. Price, $2.50 net.

Railroad men, investors, and students of economics will find the authors most thorough expositors of the principles, methods, and operation of railroad finance. The first chapter is devoted to a consideration of the economic basis of railroad investment. Promotion and underwriting, original and supplementary capitalization, the financing of construction and equipment, and organizing for financial management follow in due order. Accounts and statistics are not neglected. Insolvency is distinguished from bankruptcy and from deficit, its causes are studied, together with the effect of general business conditions on railroad earnings, and the inadequacy of early reorganizations is shown. Reorganization, consolidation, and overcapitalization form the subjects of the final three chapters, and an extended bibliography of the subject, takes up some seventy-five pages of space. The work is a distinctly commendable one, and may be consulted with confidence by those who seek information concerning the financial side of railroading.

Electricity and Magnetism. For Advanced Students. By Sydney G. Starling, B.Sc., A.R.C.Sc. New York: Longmans, Green & Co., 1912. 8vo.; 583 pp.; with diagrams. Price, $2.25 net.

The author's experience as a teacher in technical institutes qualifies him to write such an advanced text-book as "Electricity and Magnetism." The arrangement of material is based upon the derivation of the units on the electromagnetic system. That is, the procedure is from magnetism to current electricity, and from current electricity to electrostatics. Following these subjects come electrolysis, electromagnetics, alternating currents, radioactivity, etc. In all cases the aim is to thoroughly prepare the student to pass on to more technically difficult work. Where the methods of the differential and integral calculus offer any advantage, they are used without apology, since so much mathematical equipment is thought to be absolutely necessary to the really advanced student.

Meteorological Instruments and Weather Forecasts. A Practical Handbook Describing the Various Instruments used for Studying and Recording Atmospheric Conditions and Weather Changes. Price, 25 cents.

This paper-covered monograph is issued in the "Model Engineer Series," and describes the appearance and the uses of such common instruments as barometers, thermometers, anemometers, rain-gages and sun-dials. The final chapter on "Weather Forecasts" includes a short list of those popular old weather sayings which are most to be relied upon, for example, "Long foretold—long last, short notice—soon past;" and "The further the sight, the nearer the rain."

A Primer on Alternating Currents. By W. D. Rhodes, D.Sc. New York: Longmans, Green & Co., 1912. 8vo.; 145 pp.; with diagrams. Price, 90 cents net.

Students in evening classes, and in fact all those whose preparatory training has been limited, will find in this text-book explanations of alternating current theory which call for but elementary knowledge of algebra. The physics of the problems has been emphasized, and the mathematics made as incidental and subsidiary as possible. It is not claimed that the book is self-inclusive enough to be mastered at home, without a teacher, but it is expected that it will be used as a supplement to class instruction. Plenty of numerical examples at the end of each chapter aim to give the student a working knowledge of the ground he has just gone over.

The Aeroplane in War. By Claude Grahame-White and Harry Harper. Illustrated Octavo. Philadelphia, 1912, J. B. Lippincott Company.

The book before us is much too popular in style, too uncritical in its treatment, too one-sided to be of much benefit to the military man. It may be retorted that it was never intended for him. On the other hand, it will tend to give the layman a warped impression of the aeroplane in war. While there can be no question that in the battle of the future the aeroplane will play a most important part (perhaps the predominating part), the last military contest at Rheims showed that much must still be done before the absolutely trustworthy military aeroplane makes its appearance. The volume before us conveys the notion that it was written primarily to stir up feeling in England for a more extensive use of the aeroplane by the army. Sprinkled liberally through the book will be found references to England's laggard policy, as compared with the greater aviation alertness of Germany and France. While England has been slow to adopt the flying machine for military purposes, she has unquestionably acted wisely. One cannot help feeling that the primary object of this book is to "boom" the military aviation business of England. It is now well known that, were it not for governmental support, many French aeroplane makers would have gone to the wall months ago. It may be that England's aeroplane industry is in a similar position.

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